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AND

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INDUSTRIAL NOTES..... 60

Fireproof insulation for dynamos and motors is being used by the Adams Electric Co., of Worcester, Mass., which is building a line of dynamos and motors in sizes from 1 to 20 K-W. The material used is not stated. Mica has been used to a considerable extent for insulating purposes, but it is said that when once wet it cannot be dried so as to entirely recover its original insulating qualities.

The Franklin Institute calls the attention of inventors to the three medals which are awarded by it from time to time for meritorious discoveries and inventions. These are the Elliott Cresson medal, of gold; the John Scott Legacy medal, of bronze, accompanied by a premium of $20, and the Edward Longstreth medal, of silver, founded in 1889 by a former member of the firm owning the Baldwin Locomotive Works. Directions as to the manner of applying for these medals will be furnished on application to the secretary, Mr. Wm. H. Wahl, Philadelphia, Pa.

The street railways of the United States have changed as follows in the past year, according to the "Directory," issued yearly by the "Street Railway Journal":

Miles of Single Track, Including Switches.

	Horse.	Electric.	Cable.	Steam.	Total.
1892	4,460	5,939	646	620	11,634
1893	3,497	7,456	658	566	12,174
Inc. or dec.	—963	+1,517	+12	—54	+540

The "Total" does not quite correspond with the items in either case, throwing doubt on the care with which the statistics have been edited. The "steam" statistics do not seem to include elevated, but only surface railways. These remarks also apply to the following:

Number of Cars.

	Horse.	Electric.	Cable.	Steam.	Total.
1892	19,315	13,415	3,971	608	37,274
1893	16,845	17,233	4,805	616	39,509
Inc. or dec.	—2,470	+3,818	+834	—82	+2,225

Chicago, through its "Two Million Club," figures that on May 1, 1893, that city had a population of 2,016,000. But as this estimate is based upon the process of multiplying the 504,000 names in the directory by 4 1-5, it is to be taken with a large pinch of salt.

A very good record in tunneling was made during the month of December by Messrs. Chas. F. King & Co., on the Jeddo Tunnel at Ebervale, Luzerne Co., Pa. The tunnel is 7 × 11 ft. and was advanced 323 ft. in 27 days by two 3¼-in. Ingersoll-Sergeant rock drills, worked by two shifts of men, each shift working 10 hours daily.

A great improvement in incandescent lamps is claimed to have been made by the Star Electric Lamp Co., of 102 Michigan Ave., Chicago. By introducing a certain vapor into the bulb, after exhausting the air, the efficiency of the lamp or the amount of light produced for a given consumption of current is said to be greatly increased. The blackening of the bulb, as it grows old, is said to be entirely obviated and the candle power is well maintained. The company informs us that lamps made with this vapor are not yet ready for the market, but are expected to be in a very short time. Some of the lamps made on this system can be seen by our Chicago readers in the show window of the Ansonia Electric Co.

Electric cars in Milwaukee have killed 17 persons since their introduction in 1891. During 1892 there were 14 persons injured by them, and during 1893 there were 18.

For the first time in the history of the manufacture of American armor plate a failure to pass the test at Indian Head is recorded. On Jan. 10 a nickel-steel plate varying from 11½ to 14 ins. in thickness was struck by an 8-in. Haltner projectile, with a velocity of 1,631 ft. sec. The shot rebounded and was smashed to pieces, but the plate was cracked entirely through. A second shot, with reduced velocity, knocked off an end of the plate, widened the cracks and totally wrecked the plate. Another plate is to be tested, and if it should also prove inferior the entire lot of 500 tons of armor, of which this was a sample, will be rejected. These plates were made by the Carnegie company, and were to be the last of the nickel-steel, without a hardened surface, produced by the Harvey process.

The New York Rapid Transit Commission is rejoicing over the fact that at last "five men with real money" have appeared before them with an offer to bid for the franchise to build an elevated line on Mr. Bushe's plan. These men are Mr. Adolph Ladenburg, president of the Brooklyn Elevated R. R.; Mr. Frederick Uhlmann, the brewers Ruppert, Schafer and Bernheimer and "some Philadelphia capitalists." These men, through their attorney, say that they are ready to bid if the terms of sale are anything within reason, and they wish to connect the projected road with the Brooklyn elevated system and to carry passengers anywhere over the Greater New York for a 5-ct. fare. The only public objection to this scheme is that it would add to the disfigurement of the city by the erection of more elevated railways.

The annual report of the New York Board of Railroad Commissioners for the year ending June 30, 1893, shows an increase in gross earnings of $21,000,000 over the previous year for the railroad companies doing business in the state. The operating expenses and fixed charges have increased in about the same ratio, so that the net earnings are only increased about $425,000. The total mileage in the state was 7,882 on June 30, an increase of 117 miles during the year. The earnings per passenger per mile were 2.16 cts.; in 1892 they were 2.21 cts. Freight earnings per ton-mile averaged 0.777 cts. against 0.764 cts. in 1892.

The headings of the Palisades Tunnel, now being built through the Palisades from Fairview, N. J., to Cliffside, N. J., opposite 110th St., New York city, met Jan. 11. The tunnel is 5,072½ ft. long, and the time consumed in driving this was 15 months 3 days, including Sundays, holidays and lost time. Work was carried on from the two portals only, from Oct. 7, 1892, to April 5, 1893; from two portals and one shaft from April 5, 1893, to Sept. 26, 1893, and from two portals and three shafts from Sept. 26, 1893, to date. The longest stretch of bench remaining is 760 ft., and it will take 11 weeks to remove this at the present rate of progress. The Palisades Tunnel was quite fully described in our issue of March 30, 1893. The contractors are Brodhead & Hickey, and Mr. E. S. Safford, M. Am. Soc. C. E., is Resident Engineer.

The most serious railway accident of the week, and one of the most serious which we have had to record for some months, was a rear collision on the Delaware, Lackawanna & Western R. R., near the Hackensack River drawbridge, one mile east of Hoboken, N. J., Jan. 15. Owing to a heavy fog the engineman of a Dover express, to New York, had stopped near the drawbridge to look out for the bridge signal. The train was a few minutes late and was closely followed by a train from South Orange. Both trains were well filled with suburban passengers on their way to business in New York. A flagman had started back from the Dover train when he saw the South Orange train coming on rapidly, and he shouted to the passengers to jump off. The train consisted of four passenger cars and a combination baggage and smoking car in the rear. The engine of the second train telescoped this latter car, and the next two passenger cars were also telescoped. There were 11 persons killed and 46 injured, some very seriously. All of these were in the first train. The South Orange train is said to have been running at too great a speed, considering the fog, and the fact that a train and a drawbridge were close ahead. The Lackawanna Co. has a very heavy suburban traffic over this part of its line, but except for the drawbridge signal there is no station or fixed signal from the New York, Susquehanna & Western crossing to Harrison, a distance of nearly five miles. In spite of many warnings, the company has failed to adopt any approach to block working on any part of its crowded lines. We have commented upon this accident in our editorial columns.

A temporary bridge across Newtown Creek, at Meeker Ave., Brooklyn, N. Y., gave way Jan. 12 while crowded with people, and five or six persons were drowned. The bridge was a small one, for pedestrians only, built just below the new iron drawbridge (Eng. News, July 13, 1893) the approaches for which are not yet completed. The bridge was about 250 ft. long and 5 ft. wide, and had two drawspans of about 50 ft., these spans being supported by wire rope guys from A-frames, and swung by means of block and tackle. A number of employees from factories were crossing and were stopped by the opening of one of the draws. The weight of the crowd caused the structure to collapse.

A railway bridge on the North Pacific Coast R. R., crossing Austin Creek, near Cazadero, Cal., gave way under an engine Jan. 15, and seven were drowned.—A derailed snowplow broke through the bridge near Wilmot, N. S., on the Windsor & Annapolis Ry., Jan. 14; the engine, tender and plow went down and two men were killed.

A locomotive boiler explosion occurred on the Belmont branch of the Concord & Montreal R. R., Jan. 11. The accident occurred at Belmont, N. H., to the engine "Starr King," and two men were injured.

A serious derailment on the Timina & Matanzas Ry., in Cuba, was caused recently by a cow on the track. Several cars were wrecked, and about 16 persons were killed and nine injured.

The car shops of the New York, Lake Erie & Western R. R. at Jersey City, N. J., were burned Jan. 12, and 18 cars were destroyed. The loss is estimated at $122,000.

An injunction was granted on Jan. 16 restraining the Eames Vacuum Brake Co., of Watertown, N. Y., from infringing the broad claims of the Westinghouse patents on the quick-action triple-valve, which were recently sustained by Judge Townsend. The defense admitted that the Eames Co. had manufactured all the infringing apparatus sold to the New York Co.

Pumping water for irrigation by hydraulic power is the system to be adopted by the Prosser Falls (Wash.) Irrigation Co. At a point on the Yakima River where a 22-ft. fall is available, three turbines of 135 HP. each are to be installed, each of which will drive a duplex pump with cylinders 25 × 24 ins., working against a head of 160 ft. and delivering 4,000 gallons per minute. The water is to be carried from the river to the head of the canal by a 28-in. riveted steel pipe 2,800 ft. long.

The rock fill dam across the Pecos River some six miles above Eddy, N. M., which failed Aug. 6, 1893, has, in the six months past, been repaired. The original dam was built in 1890, was 1,040 ft. long and 45 ft. high above bedrock and was described and illustrated in our issue of May 17, 1890.

The prizes for the best plans for improving the water-works of Evansville, Ind., have been awarded as follows: Wilkins & Davison, Pittsburg, Pa., first prize of $1,000; Alexander Potter, Assoc. M. Am. Soc. C. E., of New York, second prize of $500; Arthur T. Tuttle, Jun. Am. Soc. C. E., of Brooklyn, N. Y., third prize of $250.

The reorganization plan of the Nicaragua Canal Co. has been agreed to by the assent of 75,000 out of a total of 117,000 shares. The detail of the reorganization plan was given in full in our issue of Dec. 14, 1893.

A Florida ship canal route is again being surveyed, this time by Mr. Frederick Ballou, of New York, the principal promoter of the new scheme being Mr. J. A. Jennings, of California. The route proposed is to commence at the Gulf end, about 15 miles below Cedar Keys; run northwest to Orange Lake, then across the lake and down the Orange River into the St. John's River, about 20 miles above Palatka. From this point the canal would go direct to St. Augustine Bay. This makes the total length of the water course about 100 miles. The canal proposed would be 225 ft. wide and 37 ft. deep. The survey is being made by private capital, and no company will be organized until further data are secured.

Another long-line electric road, between Chicago and Milwaukee this time, is said to be the real purpose of the promoters of the Northwestern Elevated Railway Co., of Chicago. The ordinance granting rights in the city to this company has been signed by the mayor. It is claimed that plenty of capital is back of the enterprise, and that the 175,000 people living between the two cities and the 250,000 inhabitants of Milwaukee itself warrant the expense. Large land holders on the route are also thought to have an interest in developing their property by a rapid transit line.

NEW RULES FOR APPROXIMATE INTEGRATION.

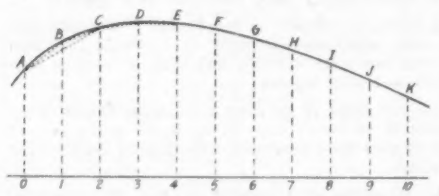
By W. F. Durand, M. Am. Soc. M. E.*

Among the various formulas used for approximate integration, the choice usually lies between the so-called "Trapezoidal Formula" and the "Simpson's Rules."

It may be noted that we have used the term "formulas for approximate integration" rather than formulas for approximate quadrature or formulas for the approximate determination of areas, because there is no such limitation to the application of the formulas in question. Any definite integral may be represented graphically by an area. Thus, let

$$Q = \int u\,dx$$

be an integral in which u is some function of x, either known or admitting of computation or measurement. Any curve plotted with x as abscissa and u as ordinate will then represent the variation of u with x, and the area between such curve and the axis X will represent the integral in question, no matter how simple or complex may be the real nature of the function u.



Suppose such curve plotted as in the diagram. The trapezoidal rule for the area O A K 10 is then as follows, writing merely the coefficients of the ordinates:

$$A = h\,(\tfrac{1}{2} + 1 + 1 + 1 \ldots\ldots + \tfrac{1}{2}) \ldots . (A)$$

This rule assimilates the contour to a series of straight lines AB, BC, CD, etc.

The parabolic or Simpson's one-third rule is as follows:

$$A = \frac{h}{3}\,(1 + 4 + 2 + 4 + 2 \ldots\ldots \ldots\ldots 1) \ldots . (B)$$

This rule assimilates the contour to a series of parabolic arcs, assumed to pass through A B C, C D E, E F G, etc., and the approximation will be accurate according to the degree of closeness with which parabolic arcs passed through such sets of three points each will approximate to the actual contour.

The increase in accuracy over the trapezoidal rule is usually quite notable, unless the number of ordinates becomes large, in which case they both approximate more and more closely to the true value and to each other.

In a series of trials made by the author upon a number of integrals of various forms for the purpose of testing the relative accuracy of these rules, it was found for cases in which the locus was of single curvature only, that the trapezoidal rule required about double the number of sections for equal accuracy with the parabolic rule. Where the locus involves several changes of curvature, as in lumpy and irregular curves, and the number of sections is moderate, one rule is as likely to be right as the other, and both are likely to be considerably in error. For a larger number of sections, however, the parabolic rule will show its superiority as above.

The chief features in the application of the two rules are as follows: For (A) we require simply a column of ordinates. Their sum is found and from this is taken one-half the sum of the end ordinates. This being multiplied by the interval h will give the integral desired. For the rule (B) we need three columns; one for ordinates, one for multipliers, and one for products, the latter being summed and multiplied by one-third the interval h, the integral is found.

The difference is therefore seen to involve the presence of two additional columns, and the work of filling in the third or product column, with the added opportunities for the commission of errors. The work of subtracting one-half the sum of the end ordinates in the trapezoidal rule may be considered as fairly balanced in the other by the greater labor of adding the product column, and the use of the factor one-third, thus leaving the net difference as stated above. Those familiar with the operation of the two rules know well what is involved in this difference, and how much more space and time the use of the parabolic rule requires than the trapezoidal. This difference, however, is usually rewarded by a substantial increase in accuracy, and the favor with which the use of the parabolic rule is regarded seems to indicate that the extra work is not considered disproportionate to the advantages received.

As a further disadvantage of the parabolic rule, we may note the limitation relating to the number of sections. This number must be a multiple of two. For certain intermediate numbers we have the so-called "Simpson's three-eighth" rule, based on a cubic parabola, but, as is well known, of the same degree of accuracy with equal values of h. This is applicable to any number of sections divisible by three. There still remain various numbers, however, such as five, seven, eleven, etc., to which neither rule will wholly apply, and to which a combination of the two, or some other rule or combination of rules must be applied. With the trapezoidal rule no such limitation exists. It is equally applicable to any and all numbers of sections.

From the foregoing it is evident that a rule which would provide the simplicity of application inherent in the trapezoidal rule, and at the same time retain substantially the accuracy of the parabolic rule would be of great value. Such a rule we now propose to deduce.

Writing the series of coefficients of the parabolic rule for the area of the diagram above, we have the upper line as given in (1). The other three lines we now proceed to explain.

$$\begin{array}{llllllllllll}
\frac{1}{2} & \frac{1}{1} & \frac{2}{1} & \frac{2}{1} & \frac{2}{1} & \frac{2}{1} & \frac{2}{1} & \frac{2}{1} & \frac{2}{1} & \frac{1}{1} & \frac{1}{2} & \ldots\ldots\ldots (1)\\
 & \frac{1}{1} & \frac{1}{1} & \frac{2}{1} & \frac{1}{1} & \frac{2}{1} & \frac{1}{1} & \frac{2}{1} & \frac{1}{1} & \frac{1}{1} & \frac{1}{1} & \ldots\ldots\ldots (2)\\
\frac{5}{12} & \frac{2}{3} & -\frac{1}{12} & & & & & & & -\frac{1}{12} & \frac{2}{3} & \frac{5}{12} \ldots\ldots\ldots (3)\\
\hline
\frac{5}{12} & \frac{13}{12} & 1 & 1 & 1 & 1 & 1 & \frac{23}{24} & \frac{7}{8} & \frac{3}{8} & . & \ldots\ldots (C)
\end{array}$$

Applying the same rule to the sections between 1B and 9J, we have the coefficients in the second line. We now make use of the five-eight rule to express the area between 0A and 1B in terms of ordinates 0, 1 and 2. This rule, as is well known, is derived from the second degree parabola, and is therefore of the same degree of accuracy as the rule already used. We have therefore:

$$A^1_0 = \frac{h}{12}\,(5 \quad 8 \quad -1) = h\,(\tfrac{5}{12} \quad \tfrac{2}{3} \quad -\tfrac{1}{12}).$$

This gives the coefficients in the third line in direct order for the section between 0A and 1B, and in inverse order for that between 9J and 10K.

We have thus, by a double application of these rules, two expressions for the same area; one in line (1) and the other in lines (2) and (3). Taking half the sum of these coefficients we have the series in line C:

Here, as may be seen, all except the three at each end are unity. For actual use, such rule might be written as follows:

$$\left\{\begin{array}{llllllllllll}
 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & \\
 & -\frac{5}{8} & +\frac{1}{8} & -\frac{1}{24} & & & & & -\frac{1}{24} & +\frac{1}{8} & -\frac{5}{8} &
\end{array}\right\} (C)$$

The ordinates would be first added as in the trapezoidal rule, and the sum modified by adding 1-6 the sum of the second from each end, and subtracting 5/8 the sum of the first and last, and 1-24 the sum of the third from each end.

This rule we have derived from an even number of sections. Taking an odd number, as, for instance, nine, we have as follows:

$$\begin{array}{llllllllll}
\frac{1}{2} & \frac{1}{1} & \frac{2}{1} & \frac{1}{1} & \frac{2}{1} & \frac{1}{1} & \frac{2}{1} & \frac{1}{1} & \frac{1}{2} & \ldots\ldots\ldots (1)\\
 & \frac{1}{1} & \frac{1}{1} & \frac{2}{1} & \frac{1}{1} & \frac{2}{1} & \frac{1}{1} & \frac{2}{1} & \frac{1}{1} & \frac{1}{1} \ldots\ldots\ldots (2)\\
\frac{5}{12} & \frac{2}{3} & -\frac{1}{12} & & & & & -\frac{1}{12} & \frac{2}{3} & \frac{5}{12} \ldots\ldots\ldots (3)\\
\hline
\frac{3}{8} & \frac{7}{8} & \frac{23}{24} & 1 & 1 & 1 & 1 & \frac{23}{24} & \frac{7}{8} & \frac{3}{8} & \ldots\ldots (C)
\end{array}$$

This gives the same modification at the ends, and only differs from the other in having an even instead of an odd number of interior ordinates with coefficient unity. It is thus seen that rule C is general, and is applicable whether the number of the sections is even or odd. For a small number of sections, no especial advantage is gained by the use of a rule in such form. For four sections the coefficients become

$$\tfrac{3}{8} \quad \tfrac{7}{8} \quad \tfrac{11}{12} \quad \tfrac{7}{8} \quad \tfrac{3}{8},$$

while for three sections the regular three-eighth rule results, thus showing the close relation between these various rules.

By a continuous application of the five-eighth rule, another series of coefficients may be produced as follows:

$$\begin{array}{llllllll}
\frac{5}{12} & \frac{8}{12} & -\frac{1}{12} & & & & & \\
 & \frac{5}{12} & \frac{8}{12} & -\frac{1}{12} & & & & \\
 & & \frac{5}{12} & \frac{8}{12} & -\frac{1}{12} & & & \\
 & & & \frac{5}{12} & \frac{8}{12} & -\frac{1}{12} & & \\
 & & & & -\frac{1}{12} & \frac{8}{12} & \frac{5}{12} & \\
\hline
\frac{5}{12} & \frac{13}{12} & 1 & \frac{11}{12} & \frac{5}{12} & & \frac{1}{24} \ldots\ldots (D) &
\end{array}$$

Evidently any number of ones may appear as intermediate coefficients, and therefore the rule is applicable to either an odd or even number of sections, and it may also be written either end first. This rule may likewise be written:

$$\left\{\begin{array}{llllllllll}
 & 1 & 1 & 1 & 1 & \ldots\ldots & & 1 & 1 & 1 \\
 & -\frac{7}{12} & +\frac{1}{12} & & & & & -\frac{1}{12} & +\frac{1}{4} & -\frac{3}{8}
\end{array}\right\}$$

Suppose next that in deriving C we express the areas of the end sections by means of the trapezoidal instead of the parabolic rule. We shall have the coefficients $\frac{1}{2}$ $\frac{1}{1}$ instead of $\frac{5}{12}$ $\frac{8}{12}$ $-\frac{1}{12}$. Combining these with the others we find the following series:

$$\begin{array}{llllllllll}
\frac{5}{12} & \frac{13}{12} & 1 & 1 & \ldots\ldots 1 & 1 & \frac{13}{12} & \frac{5}{12} & (E) & \\
\text{or} & -\frac{7}{12} & +\frac{1}{12} & 1 & 1 & \ldots\ldots 1 & 1 & 1 & -\frac{7}{12} & (E)
\end{array}$$

This rule is likewise applicable to either an odd or even number of sections.

Now, comparing E and C it may be seen that 0.4 of the first ordinate will represent a value intermediate between 5-12 and 3/8, while 1.1 the second with once the third will give an amount which is usually intermediate between 13-12, the second + once the third and 7-6 the second + 23-24 the third. Hence let us write the rule as follows:

$$\begin{array}{llllllllll}
.4 & 1.1 & 1 & 1 & 1 \ldots . 1 & 1 & 1 & 1.1 & .4 \ldots (F) & \\
\text{or} & 1 & 1 & 1 & 1 \ldots . 1 & 1 & 1 & 1 & 1 & (F) \\
 & -.6 & +.1 & & & & & +.1 & -.6 &
\end{array}$$

We thus have four rules, C, D, E, F, whose applicability and accuracy we may briefly discuss.

In the first place we note the removal of the limitation to an even number of sections. We next note that C is based upon a double subdivision of the contour into parabolic arcs, one series beginning at A and extending each over two sections, while the other series begins at B and extends similarly each over two sections. Now, "a priori" there is no reason for beginning the parabolic arcs at one point rather than at another, and we are therefore justified in claiming for the mean of such a double subdivision a greater probable accuracy than that resulting from a single subdivision. The question might depend somewhat on the law of the particular curve involved, but in general the claim to greater probable accuracy would seem to be well founded.

Rule D is likewise based on a double subdivision of the contour into parabolic arcs, and should therefore have the same degree of accuracy as C.

Rule E is perhaps slightly less accurate than C or D, due to the use of the trapezoidal rule for each end section. In any actual case, however, the difference would be practically negligible, so that for all ordinary purposes E may be considered as the equal in accuracy of either C or D, and as somewhat simpler of application.

Coming now to F, it was shown that its end coefficients are such as to usually give results intermediate between those given by C and E. Actually, therefore, its accuracy is everything that can be desired for practical purposes, and in application there is but slightly more work than with the common trapezoidal rule. In use the column of ordinates is first added. The second from each end are then added and the sum put down under the other, beginning one place farther to the right. This divides by ten. From the sum of these two we subtract 6-10 the sum of the end ordinates, and multiply the remainder by h, thus completing the integration.

In order to show the relative accuracy of the rules C and F, we have made the following comparisons at random.

In finding the value of

$$\int_0^{10} y^2\,dx$$

with unit intervals, the difference was one part in 3,333.

In finding the value of

$$\int_0^{60} \sin\theta\,d\theta$$

* Principal of the School of Marine Construction, Cornell University.

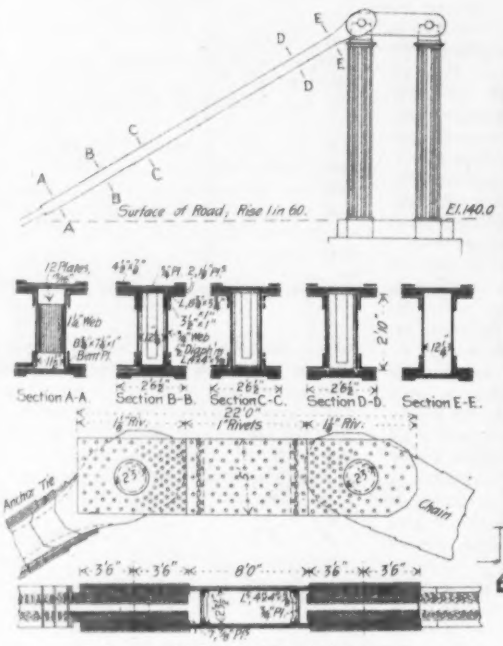


FIG. 14. DETAILS OF ANCHOR TIE.

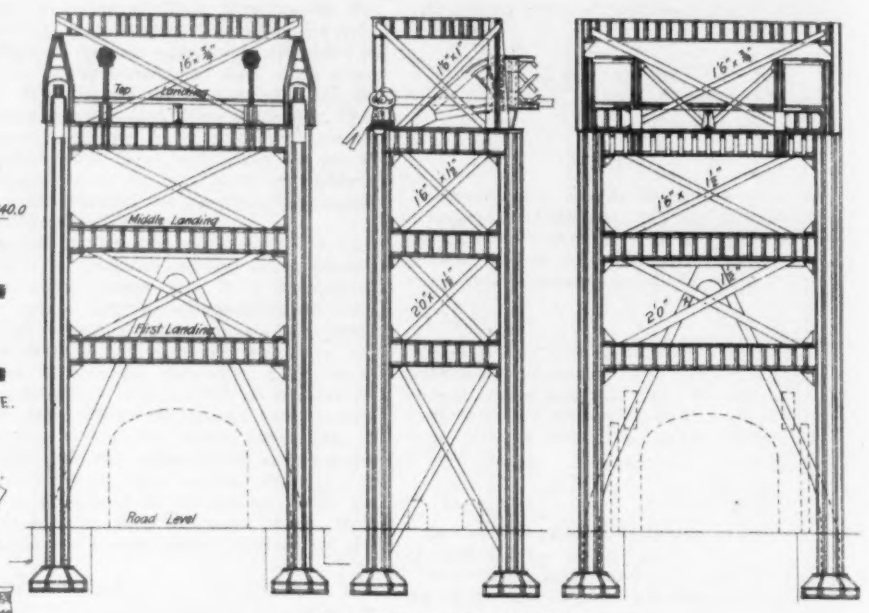


FIG. 8. ELEVATIONS OF TOWER.

FIG. 13. SUSPENSION ROD.

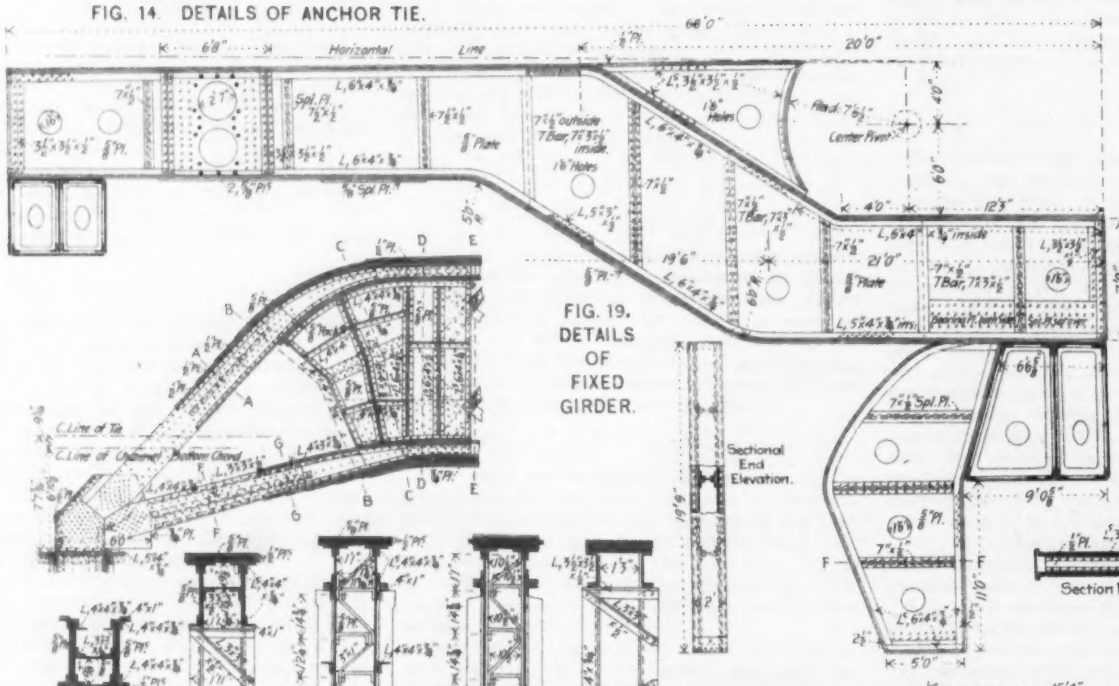


FIG. 19. DETAILS OF FIXED GIRDER.

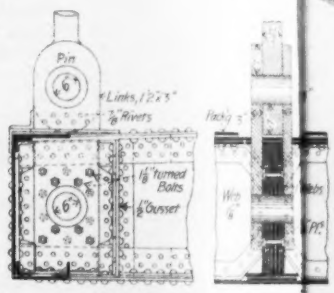


FIG. 17. CONNECTION OF SUSPENSION

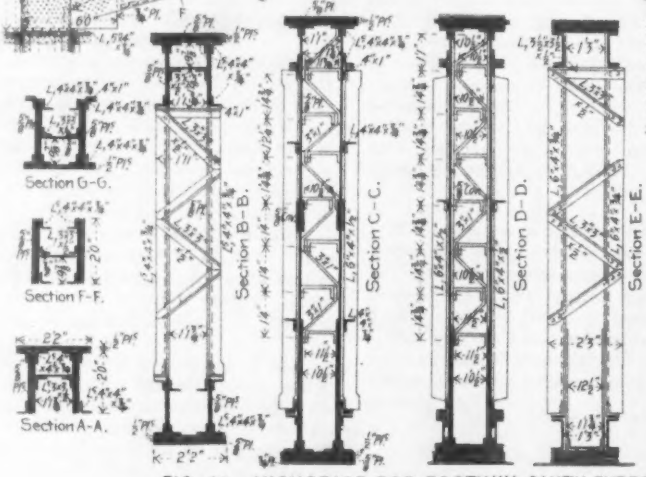


FIG. 22. ANCHORAGE FOR FOOTWAY CANTILEVERS.

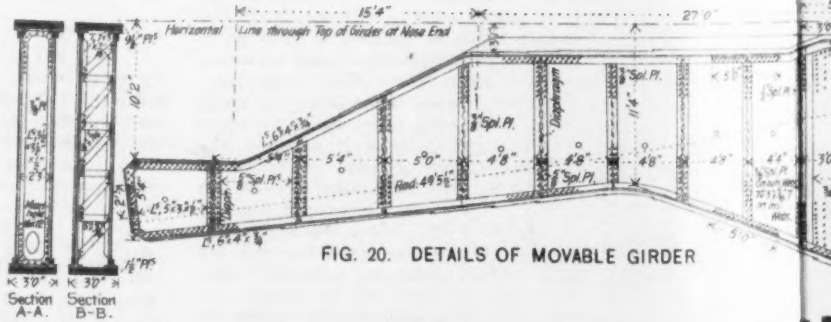


FIG. 20. DETAILS OF MOVABLE GIRDER

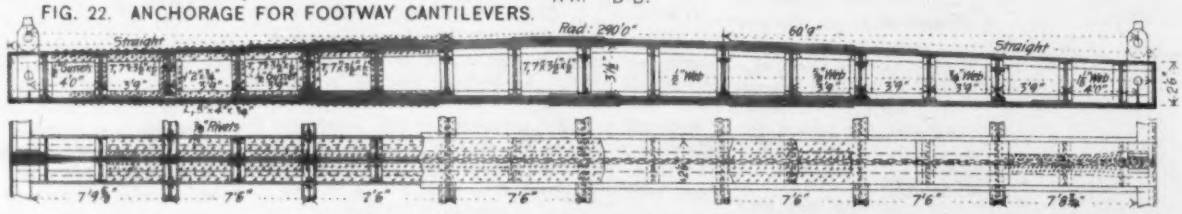


FIG. 16. ELEVATION AND PLAN OF CROSS GIRDER.

FIG. 15. PART E LONG

THE TOWER BRIDGE, LO

J. Wolfe Barry, M. Inst. C.E. Chief Engineer. Sir Wm.

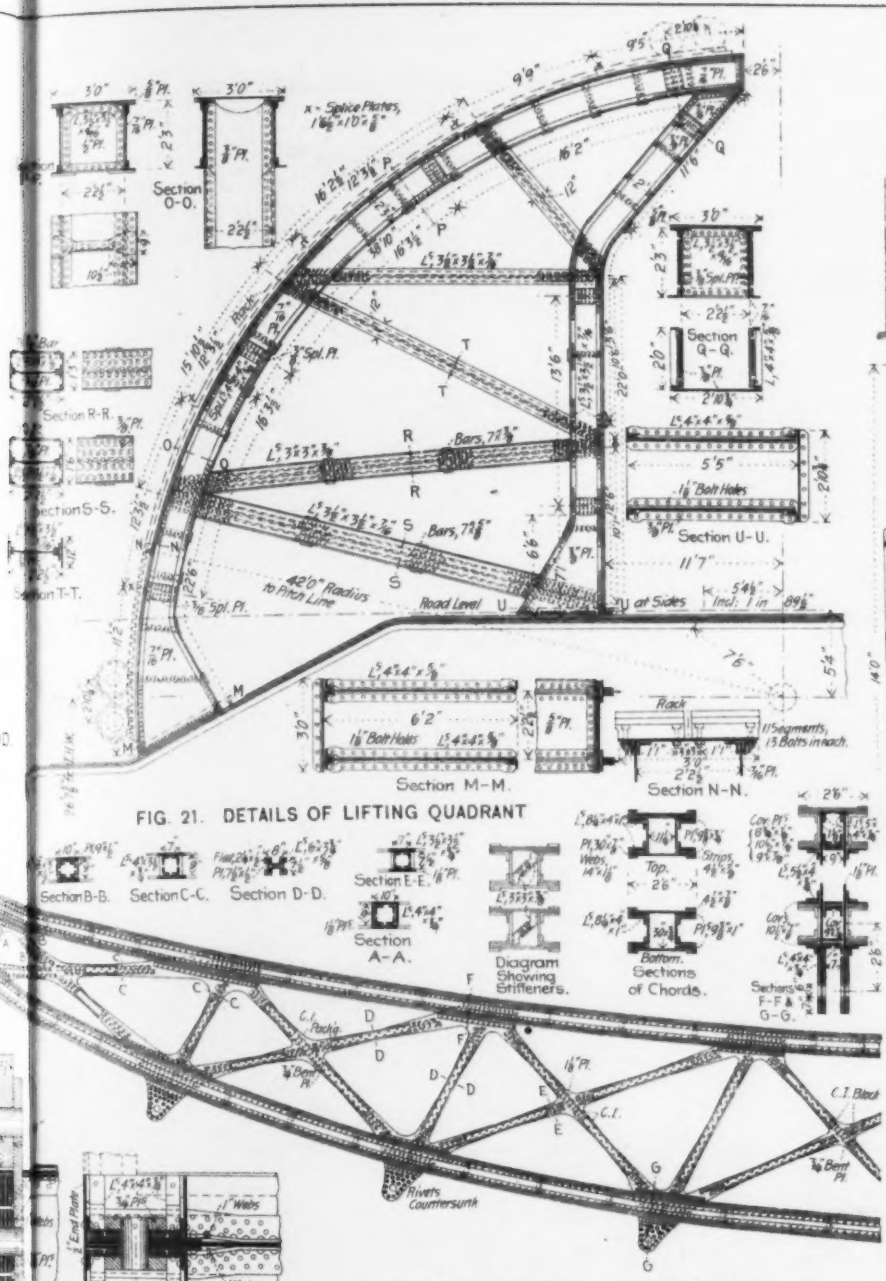


FIG. 21. DETAILS OF LIFTING QUADRANT

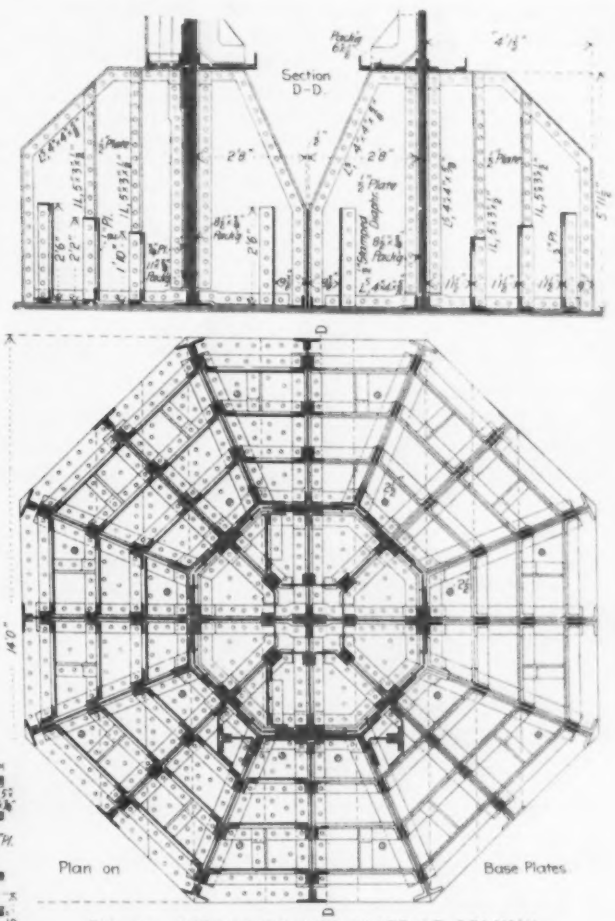
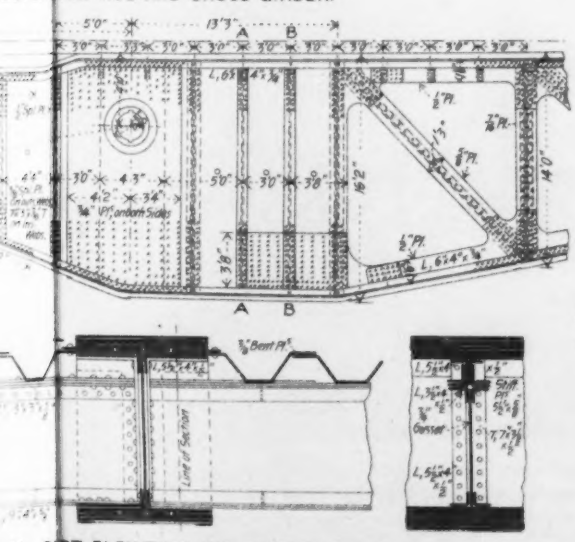


FIG. 10. DETAILS OF BASE PLATE OF COLUMN.

FIG. 12. DETAILS OF PORTION OF CHAIN.

USPENSION ROD AND CROSS GIRDER.



15. PART ELEVATION AND SECTION OF LONGITUDINAL GIRDER.

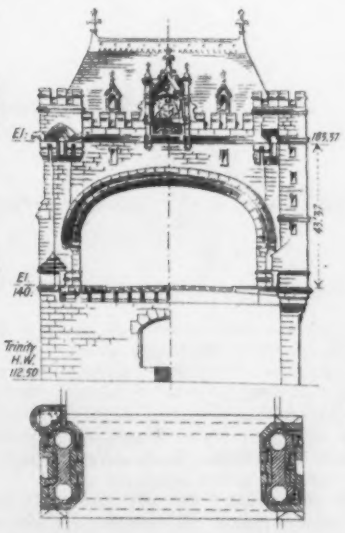


FIG. 11. ELEVATION AND PLAN OF ABUTMENT TOWER.

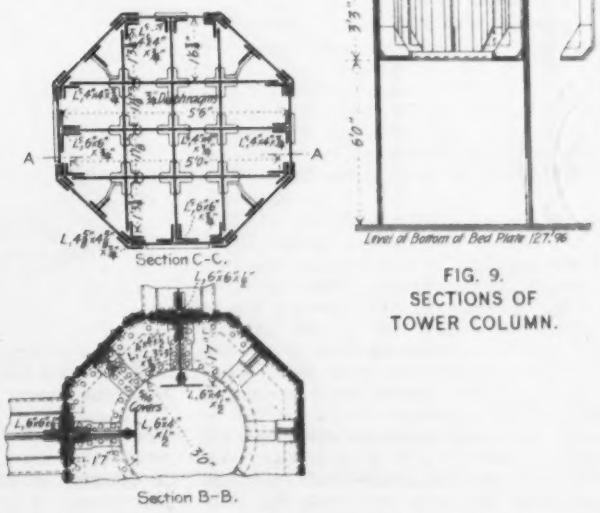


FIG. 9. SECTIONS OF TOWER COLUMN.

OGE, LONDON, ENGLAND.

Sir Wm. Arrol & Co., Glasgow, Scotland, Contractors.

CHAS. HART & SONS, LITH., 95 VESEY ST., N. Y.

with 10° intervals, the difference was one part in 143,000.

In finding the displacement of a ship of about 1,500 tons with 20 sections, the difference was one part in 125,000.

In finding the displacement of the same ship with 10 sections, the difference was one part in 18,000.

In finding the wetted surface of a ship having about 14,000 sq. ft., using 20 sections, the difference was one part in 70,000.

It will be remembered that these comparisons are with C, which has a higher probable accuracy than B. It therefore seems not unfair to claim for F substantially the full probable accuracy of B, with practically the simplicity in use of the trapezoidal rule A.

In closing, we may note certain further considerations which seem to point to a probable accuracy of the rules C and D greater than that of the rule B. In the latter, one-half of the interior ordinates have twice the weight of the other half. This is evidently wrong fundamentally, for there is not "a priori" reason for giving to one interior ordinate more weight than to another. It follows that with two adjacent ordinates, any error in one would have twice the weight which the same error in the other would have. Instead of this it is quite evident that the weights of equal errors in interior ordinates should be equal.

This requirement is fulfilled in all of the rules derived in the present paper, and this fact would seem to constitute additional ground for confidence in their equal or greater probable accuracy.

THE TOWER BRIDGE, LONDON, ENGLAND.
(With inset.)

Aside from its size and prominence, the Tower Bridge, across the River Thames, at London, England, which is illustrated in the accompanying cuts and on our inset sheet this week, possesses many features of novelty in its design and construction. It may be said at once that some of these features do not accord much with the ideas of American engineers, as developed in our large bridge constructions, and one or two appear to be open to question even after allowing for the peculiar conditions affecting the designing and building of the bridge. On account of the close proximity of the bridge to the Tower of London, it was required that its design should harmonize as nearly as possible with the mediaeval architecture of the old citadel. At the same time a masonry arch bridge or even a metal arch, which would for aesthetic reasons have been especially suitable, was prohibited by the engineering and commercial conditions. The location of important wharves above the bridge necessitated either an open span or one so high above the water as not to obstruct navigation; the banks of the river on both sides had a very low level, making the expense for approaches to a high level bridge practically prohibitory, even if they would have served the traffic as well. Finally, the act of Parliament authorizing the construction of the bridge placed strict limits to the obstruction to navigation during construction.

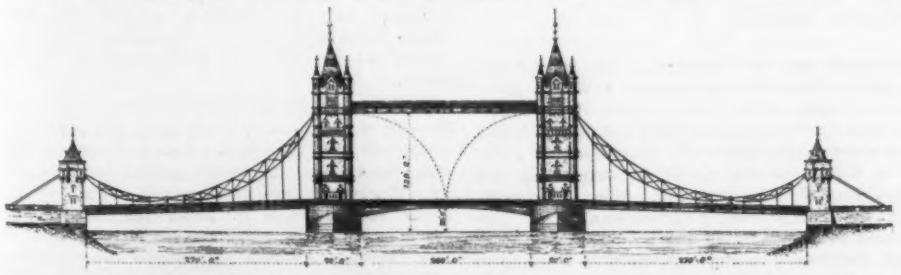


FIG. 1. GENERAL ELEVATION OF THE TOWER BRIDGE, LONDON, ENGLAND.

The general design of the bridge as constructed is shown in Fig. 1. It consists of three spans, two shore spans 270 ft. long each, and a channel span 200 ft. long, with a subsidiary footway between the river piers. These are all supported by two masonry covered steel framework towers in the river and two smaller shore towers with the masonry abutments and anchorages. Within the river towers are the engines and hydraulic machinery for operating the center span and the elevators to the footways. Three radically different systems of construction are used in the bridge, viz., the bascule system for the center span, the suspension system for the shore spans, and the cantilever system for the footways. In order to withstand the pull of the suspension spans the river towers are held together by ties concealed in the trusses of the footways. The approaches are masonry arch structures and carry a 35-ft. roadway and two 12½-ft. sidewalks. The north approach is 1,000 ft. long and the south 800 ft. long. The two side spans of the bridge proper provide for a roadway and sidewalks of the same dimensions as those on the approaches, but on the center span the roadway is reduced to 32 ft. and the sidewalks to 8½ ft.

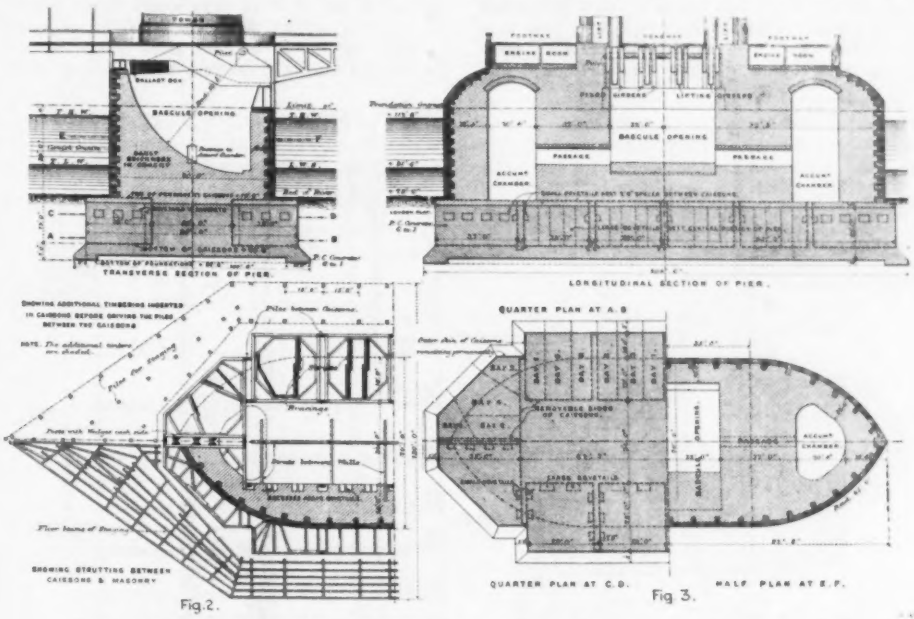


Fig. 2. Fig. 3.

FIGS. 2 AND 3. PLAN AND SECTIONS SHOWING CONSTRUCTION OF RIVER PIERS

Substructure.

Caissons.—The material of the foundation bed was a compact clay impervious to water, locally known as "London clay." A trial cylinder sunk in this clay began to settle under a weight of 6½ tons per sq. ft. The load adopted was four tons per sq. ft. of foundation bed, the skin friction of the caisson and buoyant effect of the water being disregarded. Deducting the skin friction and buoyancy and the weight of the clay excavated and replaced by masonry the pressure per sq. ft. on the clay undoubtedly comes well below the limit usually considered safe. A rough calculation places it between 2,000 and 3,000 lbs. per sq. ft. This is a very moderate load and it seems probable that it might have been exceeded safely with the result of considerable saving in masonry. In the Memphis bridge founded on a compact clay much like the London clay in its physical characteristics, the actual weight of the piers brings a pressure of five tons per sq. ft. on the foundation bed, or, deducting friction and buoyancy, about 1⅔ tons per sq. ft. Tests made here by Mr. Geo. S. Morison, the chief engineer, indicated that the clay was capable of sustaining a pressure of from 6½ to 9½ tons (2,000 lbs.) without sinking. Of course, in the Tower Bridge it was important that there should be little or no settlement on account of the machinery for operating the bascule span, and the data at hand showed subsidence at both the Charing Cross and Cannon St. bridges where the pressures on the same London clay were 7 tons and between 4½ and 5 tons, respectively.

As Parliament had prohibited the use of timber cofferdams, it was decided to use steel caissons and sink them by open dredging. Also instead of our large caisson or several smaller ones extending across the pier, it was planned to adopt a series of quite small caissons extending around the outer edge of the pier and forming an inclosure like a cofferdam. Twelve of these small caissons were used for each pier; four 28 × 28 ft. square on each side and a pair of triangular shape at each end. The arrangement of these caissons for each pier is shown in Figs. 2 and 3, and enlarged plans of the two forms in Figs. 4 and 5. A section and elevation of one of the 28-ft. square caissons are also shown in Fig. 6. The details of construction are so fully shown in these drawings as to make much description unnecessary. It is to be noted, however, that the caissons are divided horizontally at a height of 19 ft. above the cutting edge into two sections, it being the intention to remove the upper part and let the lower part remain permanently in the foundation, although as the work was carried out, two sides of the lower section were also removed. It will also be seen that the caissons were sunk about 2½ ft. apart and that provision was made for closing this space by constructing angle iron grooves from the top to the bottom at the corners of the caissons, into which sheet piling could be driven and packed watertight.

Sinking and Excavating.—The sinking was accomplished by erecting two parallel stagings on piles, one on each side of the pier, and a third somewhat wider staging between the two rows of side caissons. This arrangement will be made clear by Fig. 7. The caisson was erected on a platform between the stagings built just above low water. Two pairs of trussed beams were then placed above the caisson, with their ends resting on the tops of the stagings, and connected with the tops of the caissons by steel rods. These rods are clearly shown in Fig. 6. They are 2¼ ins. in diameter in 8-ft. lengths, and were coupled together with link plates and pins. The upper length of each rod was 14 ft. long and was screw-threaded 9 ft. from the top; this thread working through nuts and being used to lower the rods and thus the caisson. When the rod had been screwed down nearly to its whole length and it became necessary to add a new length the caisson was suspended by wrought iron hooks clipping the rods beneath the connecting link plate, as shown in Fig. 6, while

the necessary changes were made. These rods were used not only to lower the caissons to the river bed, but also during the entire sinking of the caisson to prevent uneven settlement or too rapid sinking during the excavation.

The material excavated was practically all clay. The middle part of each caisson was first excavated to a depth of 5 or 6 ft. below the bottom frame by Priestman grabs and then divers were sent down who removed the material around the sides, shoveling it toward the middle where it could be reached by the grabs. A double shift of divers, four in a square and six in a triangular caisson, were worked nine hours a day. The dredging was bed, or 53 ft. below mean high water, when the undercutting began. This consisted in cutting under the edge of the caisson 5 ft. on the outside and 2½ ft. on the sides next the neighboring caissons, and to a depth of 7 ft. for the concrete base. A toe of concrete was thus formed around the outer edge of the pier. The shape of this toe is shown in Figs. 2 and 3, and in Fig. 6 is shown the method of timbering the undercutting during excavation.

As regards the rate of progress it is to be noted that often two or three days would elapse without the lowering screws being slackened at all, either to allow the divers to gain more height beneath the bottom frame or because the lowering operations would have interfered with the erection of the upper sections of the caisson. Dividing, however, the whole depth through which the caissons were sunk by the number of days during which the divers were digging gives the average rate of sinking as 8 ins. per day up to the time when the caisson was first pumped dry. After tide work began the average daily progress was 16 ins. per day, and after the water had been excluded altogether the rate was increased to 3 ft. 9 ins. per day, working in double shifts of 10 hours each. Only two "blows" of water underneath the caissons occurred during the sinking of the entire 24 used for both piers.

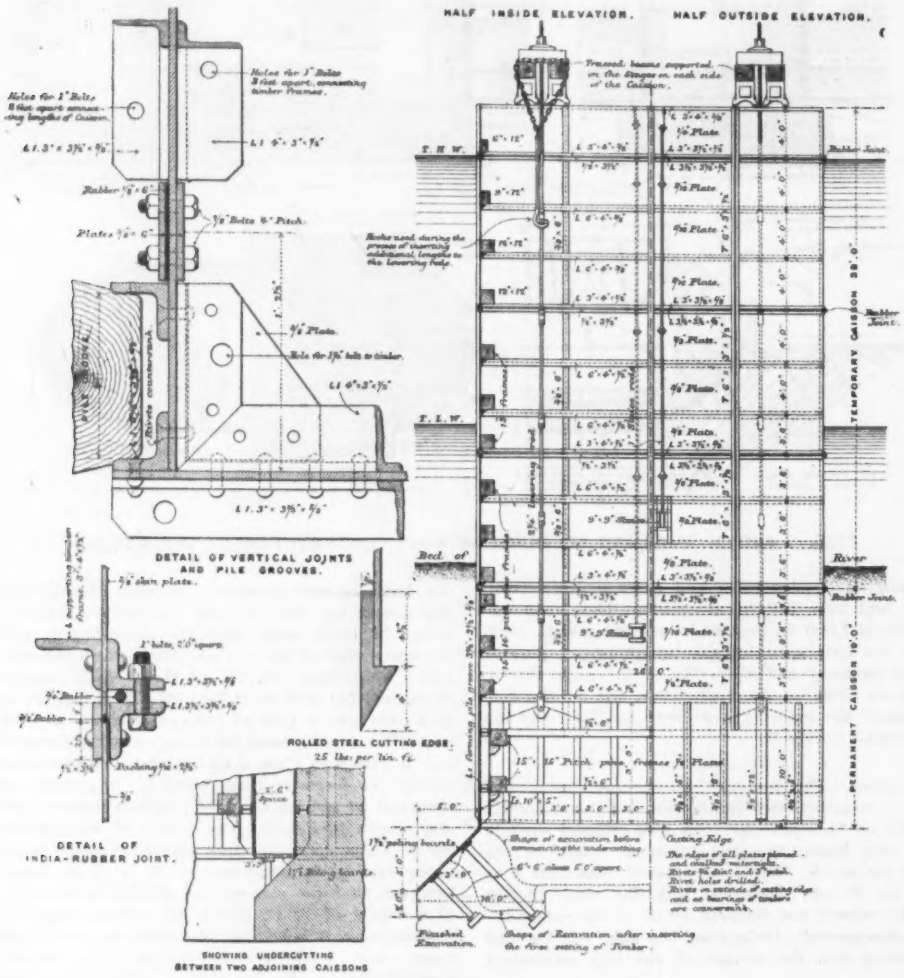

HALF INSIDE ELEVATION.
HALF OUTSIDE ELEVATION.
DETAIL OF VERTICAL JOINTS AND PILE GROOVES.
DETAIL OF INDIA-RUBBER JOINT.
ROLLED STEEL CUTTING EDGE.
25 lbs. per lin. ft.
SHOWING UNDERCUTTING BETWEEN TWO ADJOINING CAISSONS
Shape of excavation before commencing the undercutting
Cutting Edge
Shape of Excavation after inserting the first setting of Timber.
Finished Excavation.
Bed of River
River
TEMPORARY CAISSON 39'-0"
PERMANENT CAISSON 19'-0"

FIG. 6. DETAILS OF 28-FT. SQUARE CAISSON.

Concreting.—The undercutting was done in sections, three for a square and four for a triangular caisson, and as soon as each section was completed the concrete was filled in to a height of 6 ins. above the cutting edge. The lowering rods were then removed. To facilitate the removal of that side of the caisson adjoining the central portion of the pier the few rivets inside of the caisson, which held the sides together, were cut out before proceeding higher with the concrete, and to prevent the adhesion of the concrete to that side boards were laid against the ironwork and two large wooden boxes were laid against the boards to form dovetails in the concrete and thus effect a better junction between the concrete in the caisson and that in the center of the pier. These dovetails reached to the top of the caisson, but the boxes were built in sections, three sections bringing the dovetail to the top of the third frame of the permanent caisson. The concrete was built in three sections corresponding to the box sections, an interval of about one day being allowed for it to set between each section. From the top of the third frame up, boards were laid against the ironwork of the sides adjoining the neighboring caissons as well as against the side next the center of the pier, and small dovetail boxes placed between the third and fourth frames against this side boarding. Above the third frame the plates of the sides adjoining the other caissons were removed as well as on the side next the center of the pier. The finished level of the concrete was reached a few inches below the fifth or top frame of the temporary caisson. All the concrete was lowered in skips and spread in layers of about 18 ins. thickness with shovels. Its composition was six parts Thames ballast and one part Portland cement.

The next step was to complete the bond between the separate caissons. As will be remembered these were sunk 2 ft. 6 ins. apart and provided with angle iron grooves, into which piles could be driven forming narrow rectangular cofferdams between each two caissons. Before driving the piles, however, the caissons were firmly bolted together to prevent them being forced apart, and also braced, as shown in Fig. 2, to prevent distortion. The water was then pumped out and the excavation done by hand, two men working at a time, and the material raised in buckets. The inconvenience and tediousness of this work need hardly be pointed out, except for the reason that it furnishes a good example of a great objection against the use of a number of small caissons instead of one large caisson. After the sinking proper is all done there still remains a long and tedious job of "finishing up" to be accomplished. The excavation being finished, concrete was filled in to a sufficient height to enable the plates above the third frame to be removed. This being done concreting was finished to the same level as that in the caissons proper.

This bonding completed the caisson filling to the top of the permanent caissons all around the pier. A 2-ft. course of brick masonry was then laid over the entire surface upon which the granite and brick masonry of the pier above the river bed was begun. The form of this masonry will be seen from Figs. 2 and 3. It consisted of a facing of rough picked Cornish granite in from 2-ft. to 2½-ft. courses backed with brick masonry. All masonry was laid in Portland cement mortar, 1½ to 1 for granite and from 1½ to 2½ to 1 for brick. This wall of masonry was carried up all around the pier at about the same time, there being only a slight delay at the triangular caissons owing to their later bonding. After it was completed the outside plates of the caissons were removed and the excavation of the center of the pier begun.

Struts were first placed across the pier between the side walls at about water level and the water which had until then been allowed to rise and fall with the tide in this center portion was pumped out. Excavation was then carried down over the whole surface to 5 ft. below the tops of the permanent caissons, after which it was removed in four sections. As each section was excavated additional struts were placed between the walls after the inside plates had been removed. The concrete and other masonry were then placed and the pier completed ready for the ironwork of the towers. The total time occupied from the beginning of erection of the first caisson to the completion of the two piers was almost exactly four years and three months, and the total cost of both piers $555,600. The total masonry of all kinds in the two piers was 50,960 cu. yds. and the cost per cu. yd., including all subsidiary expenses, was about $11.

In reviewing this work perhaps the first question which occurs is: Why was not a single wood or steel caisson covering the whole area of the pier used instead of a dozen small caissons? It is almost certain that an American engineer would have used a single caisson and probably a timber caisson. The ease and certainty with which dim-

ber caissons can be handled make them especially adaptable for foundations of large area and no more favorable natural conditions could be asked for than were had at the Tower Bridge. The only objection to their use of much moment would be the great cost of suitable timber in England. In regard to the claim that by using a series of caissons, one whole pier and part of the other could be worked upon at the same time without obstructing the clear waterway required by the act authorizing the bridge, it is probable that enough time could have been gained by using a single caisson to make up for any loss incurred by being able to work upon but one pier at a time. It took over four years to build these two piers containing some 25,000 cu. yds. of masonry each, which is certainly very slow work. It is probably safe to say that American engineers and contractors would have reduced the time by from one-fourth to one-third, and probably more.

The five caissons for the piers of the Memphis bridge (Eng. News, May 12, 1892, Dec. 28, 1893), aggregating 67,900 sq. ft. of foundation bed area, were sunk in sand and clay to an average depth of 70 ft. below low water in two years and five months. Two of the caissons for Piers II. and III., 92×47 ft., were sunk 93½ ft. and 96.2 ft. respectively, in 1¾ and 1½ years, respectively. The total foundation area of the Tower Bridge piers is about 33,000 sq. ft. and the depth below low water about 40 ft. The largest caisson for the Washington bridge, New York city, 104.8×54.4 ft., was sunk 40.6 ft. in six months through sand gravel and rock, and the 10,400 cu. yds. (about) of masonry to the skewbacks completed in nine months. Timber caissons were used at both the Memphis and Washington bridges, and the sinking was done by the plenum-pneumatic process. The largest of the timber cribs at the Poughkeepsie Bridge (Eng. News, Oct. 29, 1887) was 100×60 ft.×104 ft. high and was sunk by open dredging through 53 ft. of water and 82 ft. of mud and mixed sand and clay in about three months and the caisson was sunk onto this crib and the masonry completed to a point 149 ft. from the cutting edge of the crib ready for steel towers in about three months more.

Superstructure.

The general arrangement of the iron and steelwork of the bridge superstructure is shown in Fig. 1. As stated before this consists of two steel framework towers and two small shore towers, a 200-ft. bascule opening span, two suspension shore spans and two high level footways between the river towers. The more important features of the ironwork for each of these are shown on our inset sheet.

Towers.—Each tower consists of four built steel columns octagonal in section and 119 ft. 3 ins. high from the bottoms of the bed plates. These columns are braced together by the steel girders carrying the three landings in each tower and by a system of diagonal bracing and wind struts. This construction is clearly shown in Fig. 8. Each of the four columns is built of T's, angles and plates, and has an external diameter of 5 ft. 9 ins. The plates vary in thickness from ⅞ in. to ¾ in. Fig. 9 shows several sections of one of these columns and Fig. 10 details of the base plate, upon which it rests. These illustrations are all of the Middlesex tower, but both towers are practically alike in construction, except in minor details. The main girders of the landing are 6 ft. deep and carry a flooring of steel plates on I-beams. Two elevators in each tower convey passengers to the different landings and to the elevated footways. Staircases are also located in each tower. The ties forming the vertical wind bracing are designed so as to bring upon each a strain of 3½ tons per sq. in. when the bridge is fully loaded with its dead weight. The shore towers somewhat resemble the main towers, except that they are much smaller, being only 39 ft. high. As stated above, the steelwork of each tower is covered with a masonry housing to give a better architectural effect. The appearance of this masonry housing is shown in Figs. 1 and 11. Rough faced granite is used for the walls and fine axe-dressed granite for the other parts. The turrets and windows are Portland stone and the roofs slate.

Suspension Spans.—The two shore spans of the bridge are constructed on the suspension system. There are two suspension chains for each span, each chain consisting of two rigid segments with a hinge connection at the center and with the anchorage systems at the shore and river towers. The shorter of the main segments measures horizontally 106 ft. 6 ins. and the longer 190 ft. 6 ins. From these chains are suspended the longitudinal and transverse girders of the roadway. A part of one of the long segments of one of the chains of the Middlesex span is shown in Fig. 12. The suspension rods are made in two parts and vary in length from 5 ft. to 80 ft. They are 5½ ins. in diameter with a screw and sleeve coupling, as shown in Fig. 13. Details of the land tie at the shore tower are shown in Fig. 14. This is a box girder 2 ft. 10 ins. deep. Fig. 15 is a part inside elevation of one of the longitudinal girders showing also the character of the floor system, and Fig. 16 shows in elevation and plan one of the cross girders to which the suspension rods are attached. Details of this connection are shown in Fig. 17 and details of the connection of the cross and longitudinal girders in Fig. 15. The cross girders are of various designs to meet the different conditions they have to fulfill, but the one shown in Fig. 16 is an ordinary girder.

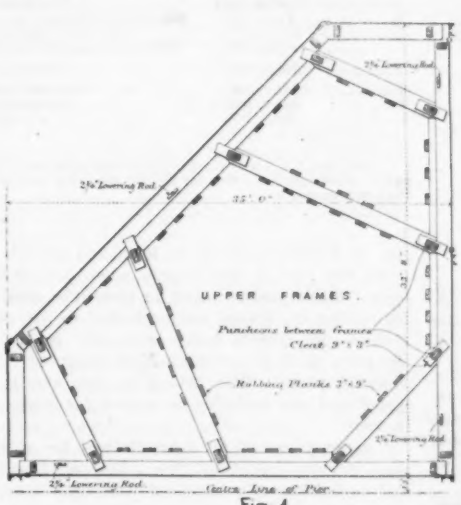


Fig. 4

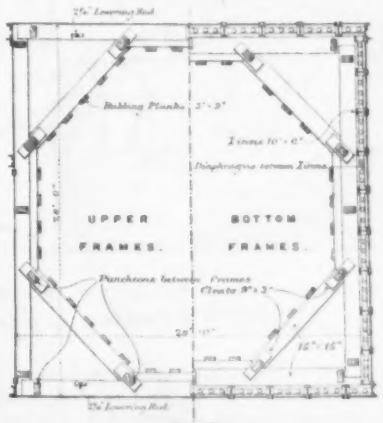


Fig. 5.

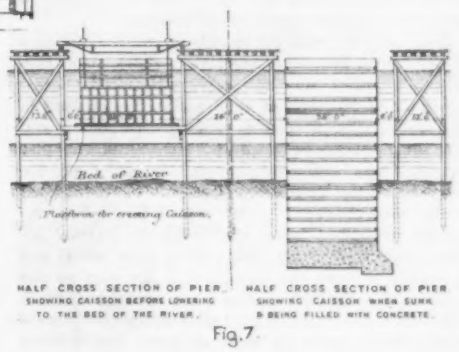
FIGS. 4, 5 AND 7. PLANS OF SQUARE AND TRIANGULAR CAISSONS AND STAGING FOR SINKING CAISSONS.

Bascule Span.—The general construction and operation of the opening span are shown in Figs. 18 to 21, inclusive. This span is 226 ft. long between the centers of pivots, and is divided into two leaves 113 ft. long and 50 ft. wide. The counterbalance leaves are about 50 ft. long. In Fig. 18 are shown the construction and operation of the counterbalance leaves. Two box girders, A and B, run transversely across the pier at each side of the bascule chamber, and these support the ends of eight fixed girders C, which run parallel to the center line of the bridge. One of these girders is shown in detail in Fig. 19. These fixed girders carry the large pedestals which form the bearings of the pivot shaft D, 48 ft. long and 21 ins. in diameter. Besides these fixed girders there are four movable girders which form in fact the opening portion of each leaf. One of these is shown in Fig. 18 E in position and in detail in Fig. 20. These movable or lifting girders are placed 13½ ft. apart c. to c., and consist of a plate girder inside the pier and a riveted truss for the portion overhanging the water. To the two outside girders are attached the quadrants to which the power is applied in moving the leaf. These quadrants are shown at F, in Fig. 17, and in detail in Fig. 21. In Fig. 18 the long dashes show the position of the quadrants when the leaves are closed and the dotted lines the position when the leaves are open. On the perimeter of the quadrant are bolted two cast steel racks, 17 ins. wide, which engage with the pinions G on the turning shafts. These racks are cut to a pitch 84 ft. in diameter. Hydraulic power is used to operate the leaves.

High Level Footways.—Subsidiary to the bascule span there are two high level footways between the river towers. Each footway consists of two cantilevers with a suspended center truss. The cantilevers are anchored to the towers, as shown in Fig. 22. Concealed in the footways are the two ties between the towers which take the pull of the chains of the suspension spans. These ties are built up of eight thicknesses of 1-in. steel plates 2 ft. deep. The plates are riveted together, breaking joints. Expansion bearings on the shore columns of the river towers and the river columns of the shore towers allow for the expansion and contraction of the suspension system.

The steel used for the superstructure throughout was made by the Siemens-Martin process and had a tensile strength of from 27 to 52 tons per sq. in. and an elongation of 20% in 8 ins. About 11,000 tons of steel were used altogether and some 1,200 tons of ornamental cast iron work.

Hydraulic Machinery.—The hydraulic machinery for operating the bascule span, elevators, etc., consists briefly of two steam pumping engines, each of 360 HP., eight large hydraulic engines and six accumulators. The pumping engines and accumulators are located near the east side of the southern approach. From here the water is conveyed by cast iron pipes laid along the southern shore span to the hydraulic engines in the south pier and thence continued up the inside of one of the steel columns on this pier, along the top of the east high level footway, and down one of the columns on the north pier to the hydraulic engines for opening the northern leaf. The boilers and pumps for supplying the pressure occupy the four arches forming the south approach.


Bed of River
HALF CROSS SECTION OF PIER SHOWING CAISSON BEFORE LOWERING TO THE BED OF THE RIVER.
HALF CROSS SECTION OF PIER SHOWING CAISSON WHEN SUNK & BEING FILLED WITH CONCRETE.
Fig. 7.

The general arrangement of the machinery on the south pier is shown by Fig. 23. Each of the two hydraulic engines at either end of the pier has three cylinders, the diameter of their pistons being for one 8½ ins. and for the other 7½ ins., with a 12-in. stroke. These engines can be used separately or together, as occasion may require. The pressure exerted by the pistons of these engines is increased by gearing before it is transmitted to the racks of the quadrants. The number of teeth of the pinions and wheels between the hydraulic engines and the quadrants, beginning at the engine, are as follows: 15, 41, 13, 20 and 13, this last being the pinion gearing with the rack. As the leaves are counterbalanced, the only forces which the hydraulic machinery has to overcome are the

friction of the main shaft, the inertia of the leaves and the wind pressure against the moving leaf. This last is placed at 56 lbs. per sq. ft. as a maximum, which brings the force applied to the quadrants 190 tons for wind pressure alone. The pivot shaft supports a weight of 1,200 tons when the leaf is open.

The hydraulic machinery is in duplicate throughout and it is proposed that, although one set alone will be used to operate the span, the other set shall have the water laid on and shall in fact follow the motion of the leaves so that in case of accident the pressure can be almost instantly applied. By an automatic arrangement the pressure is shut off at the end of the operation of raising or lowering the leaves so that no accident can happen

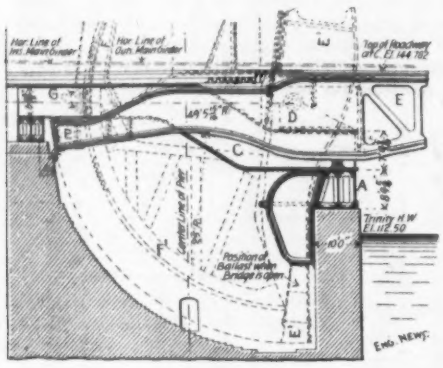

Hor. Line of Int. Main Girder
Hor. Line of Ext. Main Girder
Top of Roadway at C. El. 144 70
Trinity H.W. El. 112 50
Position of Quadrant when Bridge is open
Eng. News

Fig. 18. Section Through Bascule Chamber Showing Operation of Bridge.

owing to the carelessness of the operators. The hydraulic machinery is designed to raise or lower the leaves with a wind pressure of 56 lbs. per sq. ft. in one minute; but as ordinary wind pressures seldom exceed 10 lbs. per sq. ft. the actual time of operation will be considerably shorter.

Erection.—As will be readily seen, the erection of the heavy members, especially of the suspension spans, required unusual care. Between 13,000 tons and 14,000 tons of steel had to be handled in this work. The first step was to construct a staging or platform between the shore and the pier on each side sufficiently strong to carry all the ironwork of the suspension span and the plant used in the work. Owing to the act of Parliament requiring always a clear waterway of 160 ft. between the river piers, the center span could not be staged over in the same way. As soon as the stagings for the side spans were completed work was begun erecting the fixed girders for the bascule span. These were all built in place and riveted by hydraulic power. Work was next begun on the columns for the towers, a derrick placed on the masonry of the pier being used to handle the metal as high as it would reach. It was then placed on a staging 40 ft. high and the work continued to the platform of the first landing. The girders of this platform were built at low level and then raised to their places and riveted to the columns. The first platform being completed, the derrick was placed upon it and erection continued to the second landing and then by another change of the derrick to the third. The erection of the high level footways offered no especial difficulties, being carried out in the manner usual with cantilever spans. The ties connecting the two towers were then built, upon a platform on the top of the north tower and projecting over the shore side of that tower. As each height was added to the ties they were slid along over the center span supported by the footways until the south tower was reached. While this work was going on the abutment towers were erected. As a general rule all columns were riveted by hand.

The erection of the chains carrying the side spans was perhaps the most difficult part of the work. Timber trestles of various heights were placed 18 ft. apart along the main staging, and on the tops of these a platform 20 ft. wide was constructed. The chains were erected upon this platform in place. The portions of the chains within 40 ft. of the columns upon the abutments and piers were built by cranes placed on the columns, but the central portions were erected by means of a large steam crane on a traveling gantry running lengthwise of the main staging. A large portion of these chains was riveted by hydraulic power, although in many cases handwork had to be done. The holes for the 24 and 30-in. hinge pins were bored by special machines after all parts were in place. While the chains were being built the cross girders were brought into position and the longitudinal girders riveted to them. The suspension rods were hung after the completion of the chains.

To construct the leaves of the bascule span, the "tail end" of each of the four main raising girders was built on the main staging and then shoved forward and lowered into place so that the main pivot shaft could be got into place. This shaft is 21 ins. in diameter and 44 ft. long, and entirely supports the leaf of the bascule when the bridge is open. These girders being in place the quadrants for raising the leaves were attached to the outside girders, the girders being frequently revolved on the pivot shaft to ascertain if all parts were being properly placed. The bridge is now nearly completed and will probably be opened for traffic early in 1894.

A general idea of the magnitude of the structure may be obtained from the following dimensions and approximate quantities: The total length of the bridge, including the approaches, is just one-half a mile, and the total height of the towers from the bottom of the foundations is 293 ft. In the work there were used 235,000 cu. ft. of granite; 20,000 tons of cement; 70,000 cu. yds. of concrete; 31,000,000 bricks and 14,000 tons of iron and steel. The contract prices for the several portions of the work and the names of the contractors are given in the accompanying table.

Table Showing the Contractors and Contract Price for Various Portions of the Tower Bridge.

No. of contract.	Date of commencement.	Description of work.	Name of contractor.	Contract price.
1.....	March, 1886	The piers and abutments	John Jackson	$653,700
2.....	Feb., 1887	Northern approach, including north anchorage girder	Do.	264,400
3.....	Dec., 1887	Cast-iron parapet for northern approach	Do.	27,980
4.....	July, 1888	Southern approach, including south anchorage girder	Wm. Webster	191,915
5.....	Dec., 1887	Hydraulic machinery	Sir Armstrong, Mitchell & Co., Ltd.	426,100
6.....	May, 1889	Iron and steel superstructure	Sir Wm. Arrol & Co., Ltd.	1,685,500
7.....	May, 1889	Masonry superstructure	Messrs. Perry & Co.	745,600
8.....	May, 1892	Paving and lighting	Do.	151,600
				$4,146,795

Contract No. 1 was for the two river piers and the two abutments, up to the level of 4 ft. above Trinity high-water mark. Contract No. 7 was for all the masonry on the piers and the two abutments, above the level of 4 ft. above Trinity high-water mark.

The Tower Bridge has been constructed by the Corporation of London, under the direction of the Bridge House Estates Committee. Mr. J. Wolfe Barry, M. Inst. C. E., is Chief Engineer, and Mr. Geo. E. W. Cruttwell, M. Inst. C. E., is Resident Engineer. The facts and illustrations for this article have been taken from a paper presented to the Institution of Civil Engineers by Mr. Cruttwell, and from a series of articles appearing in recent numbers of London "Engineering," and the "Engineer." The illustrations, Figs. 8 to 23 inclusive, have been entirely redrawn for better and clearer presentation to our readers.

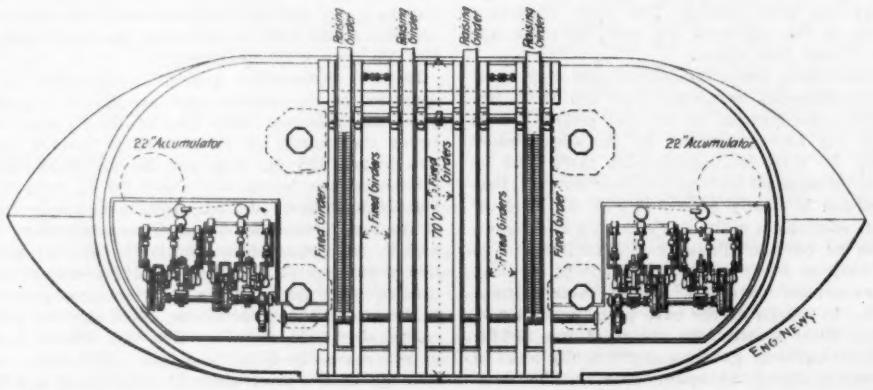


FIG. 23. PLAN OF SOUTH PIER SHOWING ARRANGEMENT OF HYDRAULIC LIFTING MACHINERY.

MUNICIPAL FRANCHISES IN DETROIT.

The fifth annual message of Hon. H. S. Pingree, Mayor of Detroit, gives an interesting summary of the progress made in securing for that city public service of various kinds at the lowest cost. After reviewing the work done in paving, on which about $750,000 was expended during the year, and on the sewer system, which amounted to $383,000, he takes up the matter of public and private lighting. For a number of years Detroit has been lit by the tower system (arc lamps on the top of slender metal towers). The contract with the local lighting company expired during the year, and after a strongly contested fight a bill was passed by the legislature and ratified by a vote of 9 to 1 in a city election, permitting the city to establish its own electric lighting plant. Bonds have been marketed for this purpose and it is expected that the new lighting system will be in operation by July 1.

Gas in Detroit was sold at $1.50 per M. ft. in February, 1893. After an extended contest between the city officers and the managers of the gas companies a compromise was finally arranged. Under its terms the price of gas is to be reduced to $1 per M. ft. after July 1. The quality is to be maintained, consumers are protected against fast-running meters, and mains must be extended on petition of one consumer for every 100 ft. of main. The city may require gas pipes to be laid in alleys wherever practicable, in order to avoid disturbance of pavements. A new franchise has been granted to the consolidated company, and peace reigns on the gas question.

An ordinance has been in force about five months under which any manufacturing firm can obtain permission to furnish electric power and light to stores and residences in its vicinity, on filing a $20,000 bond and depositing $200 as security for the replacing of pavements which may be disturbed. It is recommended that a smaller bond be received and deposits required only when a permit for opening streets is actually obtained.

It is intended during the coming summer to place underground most of the electric overhead wires now strung in the business district. Experience everywhere has been convincing that underground conduits when laid should be under control of the city. A clause permitting this to be done was incorporated in the municipal lighting bill referred to above, but was struck out by the legislature. That it is essential to a proper solu-

tion of the underground wire problem, however, appears to be admitted on all hands.

The street railway situation is discussed at length and the following is quoted nearly in full from the message:

The courts have decided that the franchises on all main lines of street railway have terminated, or will terminate within the next four years. Outside capitalists stand ready to take the property of the Citizens' company and of its bondholders off their hands at more than its actual value, and to give the people of Detroit first-class service for a 3-cent fare, provided that the city does the paving.

The people of Detroit have something valuable to dispose of, viz.: The right to use the streets for street car purposes. There are three ways in which they can be compensated for the giving of this valuable privilege.

1. By the payment of a large sum of money for each street, as has been done in New Orleans.

2. By the payment of 8 or 10% of gross receipts, as is the case in Baltimore, Toronto and some other cities.

3. By cheap fares.

First-class service must be had in any event.

I have come to the conclusion that the greatest good to the greatest number will be secured by reducing the fares. With this in view, and to enable the company to make a fair profit, I have had prepared an ordinance which provides as follows:

The life of the franchise shall be 15 years.

The city shall have the right to purchase all the property of the company at an arbitrated price, upon giving notice six months prior to the expiration of the 15 years. If no such notice is given, the franchise shall continue for another 10 years, at the end of which time everything in or on the streets, including poles and wires, shall become absolutely the property of the city; and all rights of the company to operate in the streets shall terminate.

The city shall lay all rail and pavement within tracks, and shall absolutely own and control everything in the streets, except wires and poles.

The company shall pay an annual rental to the city for the use of the tracks at the rate of $1,500 per mile for single track and $3,500 for double track during the first five years of this grant; $2,500 for single and $4,500 for double during the second five years, and $2,500 for single and $6,000 for double during the third five years of this 15-year franchise, on all tracks laid and paved or purchased and maintained by the city, from the time of such laying and paving, or purchase. Should the franchise be extended for 10 years, the mileage charge may be increased by the council, and if the company demur to the rate thus made, it shall be determined and fixed by arbitration.

The entire electrical equipment of the company shall be first-class in every respect, and shall be subject to the approval of the mayor, the committee on streets, and the board of public works.

All existing lines shall continue until such time as a general plan for street car routes for the city can be formulated by a committee of city officials and submitted to the council for confirmation. All unnecessary lines, of which there are nearly 10 miles, put in originally merely to shut out competition, and the maintenance of which is a direct charge on the people who ride, shall be discontinued.

When the general plan of routes is adopted, the city shall, within three years, extend pavements and girder grooved rails over the entire system. The company shall follow immediately with its electrical equipment.

Tickets shall be sold at the rate of 8 for 25 cts., with a single cash fare of 5 cts., with general transfers, all to be good from 5:30 a. m. to 12:10 o'clock midnight, after which hour double fare may be charged.

The company shall pay all taxes on its personal and real property.

The company shall make quarterly statements of receipts and expenditures to the common council. The books of the company shall be open to the controller, or to such other agent as the council may designate, for the verification of such statements.

A bond of $100,000 shall be filed by the company to indemnify the city from liability on account of accidents arising from the operation of the company's cars.

Other subjects discussed are the construction of a new City Hall and of fireproof public school buildings, elimination of grade crossings on railways entering the city, and reduction of the charges for telephone service. A most important recommendation is the proposition to do away entirely with the assessment and collection of water rates and make water free to all consumers, raising the funds required for operating expenses of the water department by a general tax. The cost of extensions of the mains would be assessed on the property fronting on the street.

PERSONALS.

Mr. B. R. Morton has been re-elected City Engineer of Newport, Ky.

Mr. G. M. Eldridge has been re-elected City Engineer and Superintendent of Water-Works at Americus, Ga.

Mr. J. H. Murphy has resigned his position as Assistant Engineer on the Schuylkill Valley Division of the Pennsylvania R. R.

Mr. Robert Forsyth, Chief Engineer of the Illinois Steel Co., has been appointed Second Vice-President, vice Mr. H. S. Smith, resigned.

Mr. Charles R. De Freest, of Troy, N. Y., has been appointed Secretary of the New York State Railway Commission, vice Mr. Hudson, resigned.

Mr. Hershell Roberts, of Cobleskill, N. Y., has been appointed Division Engineer on the Eastern Division of the Erie Canal, vice Mr. J. P. Keely.

Mr. J. B. Kelly has been appointed General Roadmaster of the division of the Great Northern Ry. between Minot, N. Dak., and Havre, Mont.

Mr. L. D. Latham has been appointed Superintendent of Construction of the Toronto, Hamilton & Buffalo Ry., with headquarters at Brantford, Ont.

Mr. A. N. Towne, General Manager of the Southern Pacific Ry. Co., will resign shortly and be succeeded by Mr. W. G. Curtis, Assistant General Manager.

Mr. S. Pemberton Hutchinson has been appointed Assistant Engineer of the Philadelphia Division of the Pennsylvania R. R., vice Mr. J. L. Cummings, resigned.

Mr. Joseph Hill, Assistant General Manager of the Terre Haute & Indianapolis R. R., has been appointed General Superintendent, with headquarters at Terre Haute, Ind.

Mr. Geo. H. Hutchinson, M. Am. Soc. C. E., who in June last co-operated with capitalists of Fort Worth, Tex., in organizing the Southwestern Bridge & Iron Co., has been re-elected General Manager.

Mr. J. E. Starbuck has been appointed Engineer of Maintenance of Way of the Terre Haute & Peoria Division of the Terre Haute & Indianapolis R. R., with headquarters at Terre Haute, Ind., vice Mr. Benjamin McKeen, promoted to be Superintendent of the division. Mr. Victor K. Hendricks has been appointed Engineer of Maintenance of Way of the Michigan Division, and Mr. A. J. Gibbons, Engineer of Maintenance of Way of the main line.

Mr. Gorham P. Low, M. Am. Soc. C. E., of Gloucester, Mass, died at Austin, Tex., Jan. 8, 1894. He had been engaged for several months in charge of work on the Austin dam and the public works in connection therewith. He was stricken with paralysis on Christmas day. His condition was hopeless from the beginning, but he lingered two weeks before death came to his relief. The Board of Public Works of the city of Austin passed the following resolutions on the announcement of Mr. Low's death:

Whereas, Mr. Gorham P. Low, Civil Engineer, employed by the Board of Public Works of the city of Austin, Tex., and in charge of the works at the dam, departed this life to-day, Jan. 8, 1894, at 11:30 o'clock a. m.

Resolved, That during the six months Mr. Low was employed by the Board of Public Works he not only demonstrated his superior qualifications as a civil engineer, but by his gentlemanly manners he endeared himself to every member of the board, and we regard his death as not only a great loss to the engineering profession, but also as a great loss to all who enjoyed his personal acquaintance, and especially to the city of Austin.

Resolved, That a committee of three be appointed from the Board of Public Works to take charge of and see that Mr. Low's remains are properly forwarded to his former home.

NEW PUBLICATIONS.

ELEMENTARY LESSONS IN STEAM MACHINERY AND THE MARINE STEAM ENGINE, with a short Description of the Construction of a Battleship. Compiled for the Use of Junior Students of Marine Engineering. By Staff Engineer J. Langmaid and Engineer H. Galsford, R. N. London and New York: Macmillan & Co.; 8vo; pp. 267; 93 cuts and plates; $2.

The nature of this work is sufficiently indicated by its title. It is naturally a very elementary treatise, all problems too intricate for a beginner being passed over, but the illustrations are excellent and the text clear and concise. We are surprised to find the laws of friction stated very incorrectly, according to the ideas of 20 or 30 years ago, and without even a reference to modern experiments, which have completely overturned the old so-called "laws."

TRADE PUBLICATIONS.

RIEDLER PUMPING ENGINES.—Fraser & Chalmers. Chicago and London; pamph.; pp. 12.

The method of constructing pumping engines with valves in the water end moved by positive mechanical connections has come into extensive use in Germany, that country being the home of the inventor of the system, Professor Riedler. The manufacture of this type of engines in this country has been taken up by Messrs. Fraser & Chalmers. The first Riedler pump built by them is now working in the mines of the Boston & Montana Co., of Butte, Mont., forcing 900 gallons per minute against a head of 640 ft. At present 44 mine pumping engines and over 100 waterworks pumping engines built on this system are working abroad, and its record has been such that it may fairly be expected to become popular in this country. Compressors and blowing engines are also built on this system and are claimed to give exceedingly high efficiencies.

SOCIETY PROCEEDINGS.

CIVIL ENGINEERS' CLUB OF CLEVELAND.—At the meeting on Jan. 9, the president and 57 members and visitors present, Mr. Geo. E. Gifford presented a paper entitled "Design of the King Bridge Co.'s New Riveting Shop," and Mr. H. F. Coleman presented for discussion a type of truss recently constructed by him. Frank C. Osborn, Secy.

OHIO BOARDS OF HEALTH.—A meeting of the state and local boards of health will be held at Columbus, O., Jan. 25 and 26. Mr. Josiah Hartzell, of Canton, will read a paper on "Sewage Disposal at Canton" (Eng. News, June 1, July 20, Sept. 14, 1893) and Dr. R. D. Kohle, of Lima, will read one on "House Drains." Most of the other papers will relate to the prevention of infectious diseases.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.—The eleventh annual meeting was held Jan. 8, with 12 members present, including the president. The following officers were elected for the ensuing year: President, Geo. L. Wilson; Vice-President, J. D. Estabrook; Secretary, C. L. Annan; Treasurer, A. O Powell; Librarian, A. Munster; Representative on Board of Managers of Association of Engineering Societies, C. J. A. Morris. C. L. Annan, Secy.

NEW ENGLAND RAILROAD CLUB.—The meeting on Jan. 10 was held in Wesleyan Hall on Bromfield St. Prof. C. Frank Allen, of the Massachusetts Institute of Technology, read a paper on "Railroad Building with Reference to Economy in Operating." The paper was discussed by Messrs. Tyler, Marden, Turner, Ellis, Lauder, Purvis, Sutherland, Graham and others. The club begins this year the publication of full verbatim reports of the proceedings of each meeting. Copies can be obtained by addressing Mr. F. M. Curtis, Secretary, O. C. R. R., Boston

SCRANTON ENGINEERS' CLUB.—The first annual meeting of the club was held on Thursday evening, Jan. 11, 1894, at the rooms of the "Colliery Engineer," Scranton, Pa. An organization was effected and 43 charter members were enrolled.

A constitution and by-laws were adopted, and the following officers elected for the ensuing year: President, James Archbald, Sr.; Vice-President, F. W. Gerecke; Treasurer, A. H. Storrs; Recording Secretary, H. W. Rowley; Corresponding Secretary, C. C. Conkling, 820 Pine St., Scranton, Pa.; Directors, W. A. May, Henry Wehnun, R. J. Foster.

The regular monthly meeting will be held on the evening of the second Saturday of each month.

C. C. Conkling, Secy.

CENTRAL RAILWAY CLUB.—The annual meeting will be held at Hotel Iroquois, Buffalo, N. Y., at 10 a. m. on Jan. 24. The subjects for discussion will be: "Air-Brakes, Their Maintenance and Inspection," J. A. Chubb, Jas. Macbeth and Robert Gunn, Committee; "Leaky Flues in Locomotives," J. D. Campbell, Lamott Ames and W. A. Foster, Committee. The committee appointed to arrange for the annual dinner recommends that in view of the general business depression the banquet be given up, and that a sum of money now in the hands of the committee be devoted to Buffalo charities. S. W. Spear, Secy.

NEW ENGLAND WATER-WORKS ASSOCIATION.—The principal paper before the monthly meeting, held at Boston on Jan. 10, was on the "Construction of Reservoir Embankments." It was presented by Mr. L. A. Taylor, M. Am. Soc. C. E., and was followed by discussion.

Mr. Taylor stated that he believed it to be easier to build a watertight earth embankment than one of masonry or concrete, ordinary sections being employed in each case. He did not remember of an embankment failure because of percolation through the body of the structure, the leaks causing failure always being at some point where it is difficult to make a close bond, as along a pipe or along the natural ground surface.

A large part of Mr. Taylor's paper was taken up with a description of the methods employed in repairing a break in the Lynde Brook reservoir embankment of the Worcester Water-Works, which occurred in 1876 (Eng. News, April 1 and 8, 1876). A full abstract of this part of the paper will appear in a following issue.

Some of the short experience papers which render the winter gatherings so attractive to many were presented at this meeting.

CONNECTICUT ASSOCIATION OF CIVIL ENGINEERS AND SURVEYORS.—The tenth annual meeting of the association was held at Hartford on Jan. 9. Mr. A. K. Wadsworth, secretary of the association, described the failure and repair of a dam. Mr. Burr K. Field, Vice-President of the Berlin Iron Bridge Co., presented a paper entitled "Novel Features in Shop and Mill Construction," an abstract of which will be given later. Mr. R. A. Cairns, City Engineer of Waterbury, described the works now being built by that city to furnish a new water supply.

The source of supply which is now being developed was discovered by Mr. Cairns while examining the new state topographical map of Connecticut, and work on the pipe line has been carried on for some time. It is proposed to build a masonry dam to impound 70 ft. of water on the West Branch of the Naugatuck River some ten or twelve miles from the city. The water surface of the reservoir thus formed would be about 280 ft. above Center Square and the storage capacity would be some 600,000,000 gallons, which, with the stream flow, would provide 6,000,000 gallons per day in the dryest weather. A 36-in. cast iron supply main ten miles long is proposed, which would cross the stream on which it is located four times, by means of iron bridges, and cross beneath the Naugatuck River once. So far the work on the pipe line has been done by day labor, but it is hoped that contracts for the entire work will be let by next summer.

ENGINEERS' CLUB OF ST. LOUIS.—At the meeting on Jan. 3 Mr. Winthrop Bartlett addressed the club on "Street Railways." The total mileage in St. Louis in 1886 was 147, and the number of passengers carried was 47,000,000. At the close of 1893 the mileage had increased to 279 and the passengers to 92,000,000. Some special features of the new Cass Ave. line were given. Tests of station efficiency ranged between 80 and 92%, but the latter result was considered abnormal. The wear of rails and the power required for starting and operating cable trains were also considered.

In the discussion Mr. Richard McCulloch stated that the power to drive cable roads in the city averaged 11 HP. per train, of which 7 HP. was required to move the cable. For electric roads the power was 13½ HP. per train. These figures were much more favorable to electric roads than was commonly believed to be the case. The consumption of coal was still more favorable to electricity, being slightly less than the cable. This discrepancy, however, may be slightly due to a better steam plant. He stated that the data collected by him indicated that roads operating less than 30 cars would find electricity preferable to the cable, while the reverse would be true for a traffic requiring more cars, providing the conditions as to curves and grades were favorable to the cable.

In the discussion it was announced that a contract had been made for the use of welded rails on the Baden road in the city. Wm. H. Bryan, Secy.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—The eighth annual meeting was held at Montreal, Jan. 9 and 10. On the first day a visit was paid to the new power house of the electric railway company. The plant includes six horizontal cross-compound Corliss condensing engines of 600 HP. each, built by Laurie Bros., of Montreal. The cylinders are 24 x 48 ins., and the driving wheels 24 ft. diameter, each engine driving two generators of 200 K-W. Steam is supplied by twelve Lancashire boilers, made in England, each boiler 28 ft. long and 7 ft. diameter, and carrying 125 lbs. pressure. On Jan. 10 the annual report was read, showing a decrease of 14 in the total membership. There are now 7 honorary members, 283 members, 133 associate members, 60 associates and 150 students, or 633 in all. The report of the committee on professional status, submitted by Mr. A. Macdougall urged that an appeal be made in each province to have members of the Canadian Society of Civil Engineers of all grades recognized as professional men, with the right to collect and sue for fees; and that no practitioner be entitled to designate himself a civil engineer unless he belongs to the society. The report also stated that nearly all the members who had been consulted were in favor of having a close corporation. Mr. Macdougall, in presenting the report, said the great difficulty which presented itself was that the society was formed under a Dominion charter, and it was a question, if they became a close corporation, whether they would not find provincial difficulties arising. He strongly advocated raising the standard of professional etiquette and honor. After a long discussion the report was referred back to the committee to report to council by Oct. 1.

Mr. P. A. Peterson presented the report of the committee on cement testing. The report pointed out that France, Germany, Austria, Switzerland, Norway, Sweden and Russia had carefully considered standard tests. England as yet had none. They drew attention to the establishment of testing bureaus at McGill University, the Toronto School of Science and the capital, and urged that a uniform standard be established. This report was also referred back to the committee for further consideration.

Mr. W. J. Sproule read a report drafted by several members of the committee on professional ethics. It was a carefully prepared digest of, 1, the duties of engineers to employers and of employers to engineers; 2, the duties of engineers to other members of the profession, and 3, the duties of engineers to the public and of the public to the engineers. A separate report on the same lines, by Sir Casimir Gzowski, was also read, and as no uniform report was submitted the duties of the committee were continued.

The election of officers resulted as follows: President, P. Alex. Peterson, Montreal; Vice-Presidents, Herbert Wallis, Montreal; Alan Macdougall, Toronto; P. W. St. George, Montreal; Treasurer, K. W. Blackwell, Montreal; Secretary, C. H. McLeod, Montreal; Librarian, William McNab, Montreal; Members of Council, H. T. Bovey, Montreal; John Galbraith, Toronto; H. N. Ruttan, Winnipeg; P. S. Archibald, Moncton, N. B.; G. C. Cunningham, Montreal; G. H. Duggan, Montreal; William Haskins, Hamilton; H. A. F. McLeod, Ottawa; J. D. Barrett, Stratford; L. A. Vallee, Quebec; Hiram Donkin, Mulgrave, C. B.; Hurd Peters, St. John, N. B.; Harry Abbott, Vancouver, B. C.; G. H. Garden, Montreal; Octave Chanute, Chicago, Ill.

Mr. Hannaford, the retiring president, delivered an address, in which he gave valuable information as to the cost of materials used in the construction and maintenance of railways in Canada, the result of his long experience as Chief Engineer of the Grand Trunk Ry.

ENGINEERS' CLUB OF PHILADELPHIA.—At the meeting of Jan. 6, 1894, Major J. W. Powell, Director of the United States Geological Survey, gave a very interesting talk on "The Engineering Problem of Irrigating Large Areas," illustrated by maps showing the mean annual rainfall, the mean annual runoff, and the comparative elevation of different sections of the United States by color sections; also a chart showing diagrammatically the portion of improved land to the total area of the different countries of the world. He said in substance as follows: For more than a century experiments have been conducted by agriculturalists, especially abroad, which show (without going into figures) that plants need a great deal of water, some of course more than others. Grass, for example, draws up and exhales its own weight each day. Most of the vegetables and fruit require more. With such a product as hay, we must, of course, remember that only the part which is used is taken in the above statement, so that to produce 100 tons of hay, we should require about 200 tons of water daily. The quantity necessary varies also with the latitude and the elevation, being more in the northern than in the southern part of the country, and on low than on high ground. In the north, on high ground, it varies from 12 to 24 acre-inches per acre of crop, or an average of 18 ins. for each crop. Throughout the arid regions of the West, 4,000,000 acres are now cultivated by irrigation, the people using from 24 to 36 ins. per acre. This is more than is absolutely necessary, however, as in some places where the water is valuable it has been found possible to reduce its duty to 20 ins. In such cases, the best conditions of course prevailed. Water is piped and carefully distributed, the land is properly prepared, and nothing grown upon it but the crop desired. We can therefore state as the amount of water necessary for absolute duty 18 ins., for economical duty 20 ins., and for practical purposes 24 ins., more than that being useless. By careful examination of the figures for rainfall and runoff, or the maps on which they are graphically represented, it will be seen that even by applying every river in the West for irrigation the area which it will be possible to reclaim is still very restricted. In the Eastern regions the rainfall is of course very considerable; for instance, in the Potomac section, there is a mean fall of 40 ins., of which half is evaporated and half runs off. In the section further west, where the rainfall is about 10 ins., if all of the water could be captured less than half of the land could be irrigated with a practical duty of 34 acre-inches. In the southwestern part of the country, only about 1 acre in 1,000 can be irrigated.

It will be noticed that in the matter of irrigation in the West, the rainfall cannot be calculated upon, as it is very infrequent and variable, while the growing season is a constant factor, and the farmer must depend on supplying by artificial means the entire amount necessary during that time. The great body of the rainfall is caused by the occasional and sometimes heavy storms which occur, and which are favorable to the formation of streams, especially in the hilly countries, where they are sometimes very rapidly filled and swollen. In the Grand Canon of Colorado, for instance, I have seen the river rise 50 ft. in one night from the great storms which immediately preceded. The water from the streams is not always taken directly to the land to be irrigated, but much of that which condenses on the Western mountain ranges, not running toward the sea, is collected in lakes, etc., and from thence it can be readily applied to irrigation. In our Western arid region of 1,000,000,000 acres it might be possible, if all the water could be utilized, with a 20-in. duty to irrigate 100,000,000 acres, but practically not more than 50,000,000 could be used. By the chart showing the proportion of improved lands to total area, it will be seen that the country of Denmark leads with about 80%, with Illinois following with about 70%, Pennsylvania about 45%, and the whole United States about 16%. Another important point to be considered is that artificial irrigation is not only to be used where it is necessary for any growth, but by its use, under scientific operation, it is possible to increase the growth per acre to quite a wonderful extent. Just the right amount of water should be applied to the land, too much being as bad as too little, and an average of about 60% of saturation being proper for the best growth. The soil should also be aerated and drained. The intensive methods of production under glass, etc., are spreading very rapidly, and most of the great yields of fruit, etc., which one hears of are grown in this way. This question of irrigation also affects our modern civilization, for it is undoubtedly a fact that the growth of population in the suburbs of cities is largely due to the amount of intensive agriculture which is there carried on near the city markets. In some parts of the West it costs from $5 to $30, sometimes even $100, an acre to bring the necessary water through dams, canals, etc., and the best possible crop must be produced near a good market. Around some of the cities in California tram and electric roads run out to suburbs which have grown up about the intensive farming industry.

L. F. Rondinella, Secy.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The first of a series of monthly meetings for the discussion of current engineering topics was held at the society's house, 12 W. 31st St., New York city, on the evening of Jan. 10. Mr. C. W. Hunt occupied the chair, and the meeting opened with a statement by Mr. M. N. Forney as to the plan and scope of the meetings. To obviate possible objections on the part of members living at a distance from New York, they are not to be held as meetings of the society, and the proceedings will not be published in the Transactions. Members will have the privilege of inviting friends to the meetings, who may, with the consent of the chairman, take part in the discussions. It is proposed at each meeting to have presented some brief practical paper, not more than 30 minutes in length, to be followed by discussion in which each speaker shall be strictly limited to five minutes. The meetings will begin at 8 p. m. and will close promptly at 10:15. The committee are agreed that heavy, ponderous papers, such as frequently swamp the flow of discussion in technical meetings, are not suited for the meetings proposed to be held, and they will endeavor not to have any of the opening papers of such a character or such a length as to exceed the limit of elasticity of the attention of the audience.

Responses to the circular announcing the proposed series of meetings were received from a large number of members, all of whom signified their approval of the plan.

The evening's discussion was opened with a paper by Mr. F. F. Hemenway, editor of the "American Machinist," on the steam engine exhibits at Chicago (see Eng. News, Aug. 24, 1893). Comparing the steam engine exhibits at the Centennial and at the Columbian Expositions, he said that the prevalence of the compound engine at Chicago with the fact that no compound engines were shown at the Centennial was a good illustration of the progress made in compounding during the past 17 years. Referring to the Centennial Corliss engine, he said that, considered architecturally, there was nothing in the exhibits at Chicago that could compare very favorably with it. Probably in the interest of progress there ought not to have been.

The valve mechanism of the Allis quadruple expansion engine was notable for the employment of a supplementary eccentric for controlling the point of cut-off, which permitted the unlatching to occur at any point up to practically full stroke. Objection has been made to the ordinary Corliss gear because the steam valves must be tripped, if at all, somewhat before the half-stroke of the piston. This objection, for obvious reasons, would have greater force in the instance of multi-cylinder compound engines.

The end aimed at by the use of this eccentric has for some time—and notably in England—been at least partially accomplished by the use of two eccentrics,

one for the steam and one for the exhaust valves. By this means it is possible to extend the point of unlatching until, practically, half-stroke, and this will prolong the expansion until about three-quarter stroke, the piston at half-stroke being at its fastest travel. Three-quarter stroke is perhaps late enough for cut-off in any engine used for ordinary purposes.

It seems probable that there is some gain in the use of separate eccentrics for steam and exhaust valves, through the possibility of a more advantageous arrangement of the exhaust valves and their operating mechanism, as the steam valves are not influenced by the change made in this respect.

This feature of construction was not shown at Chicago. The E. P. Allis Co. built engines with separate steam and exhaust eccentrics seven years ago, but do not recommend them except for the low pressure cylinder of compound or triple expansion engines when it is desired to carry expansion beyond half stroke.

Broadly speaking, there has been little improvement in Corliss engines since the Centennial and for some time previous to it. The Bates-Corliss engine has an ingenious valve gear designed to do away with the unlatching feature of the Corliss gear while giving a similar motion to the valve. It appears to work satisfactorily, but it remains to be seen whether some feature more objectionable than unlatching will not be developed in the mechanism by use.

High-speed engines were shown at the Centennial, but have come into use chiefly since then. The Buckeye Engine Co. and Mr. Chas. T. Porter were among the pioneers in this direction. The influence of the latter was traceable in many particulars in the engine exhibit at Chicago. The discussion as to relative merits of high speed and low speed seems to have resulted in the conclusion that each is best for its place. The important improvements in high-speed engines have been in the direction of more perfect and certain lubrication, accurate balancing, and regulation of speed with the greatest accuracy.

In foreign engines the Willans engine was an interesting departure. The central valve affords an excellent means of removing the water from the cylinders, and the direct air cushion secures smooth running without affecting the steam distribution. Although the engine has an unusually short stroke, is single acting, and is regulated by a throttling governor, it is credited with a remarkable economic performance under test. It may be remarked that with a properly adjusted load and constant steam pressure the objections to a throttling governor disappear. This engine is used largely in England for electric lighting, the installation being such that of several engines only as many need be kept in operation as will be what is considered properly loaded, the governing being done by one engine. They are manufactured strictly interchangeable in every detail. This does not necessarily make the engine better, but it must cheapen the cost of production.

Air cushioning was also shown on the Westinghouse 1,000-HP. compound (Eng. News, Aug. 24 and Sept. 21).

Another noticeable feature was the growing use of independent air pumps. While these have been in limited use for a long time, they have been brought to their present state of perfection since the Centennial.

An unfortunate feature of the engine exhibit was the numerous breakdowns and failures of some of the engines which were apparently in the experimental stage.

Discussion.

Prof. J. E. Denton said that one notable innovation at Chicago was the Allis vertical engine, in which the steam was worked on a new system: the governor, when the engine was above speed, kept the valve entirely shut, and when the engine was below speed it opened the valve at a fixed cut-off. The idea was to avoid a short cut-off at light loads and thereby reduce the cylinder condensation. It was a great disappointment to the Committee on Engines that some tests could not be made of that engine. What compounding or multiple expansion has done is, of course, simply to keep the per cent. of loss by cylinder condensation constant as the ratio of expansion has changed from 4 or 5 to 25. This Allis engine aimed at the reduction of cylinder condensation in a new way, and a test of it would have been very interesting.

Respecting the relative merits of the Allis quadruple expansion and the Fraser & Chalmers triple expansion, the quadruple saves a small amount of fuel by reducing cylinder condensation. Against this must be set interest and depreciation on the fourth cylinder with its attached parts.

The Willans engine referred to above has shown wonderful economy; and if they can obtain such results in every day practice, the use of large Corliss engines to drive dynamos is likely to pass away. With 400 revolutions a minute, 170 lbs. steam pressure, and only 13 expansions, the Willans engine claims a steam consumption of 12¾ lbs. of water per HP. That is as low a record as a Corliss triple expansion can be relied on to give. The Willans engine also offers the simplicity of a throttling governor and challenges the world to show that the automatic cut-off will ever save anything of any account. As Mr. Hemenway has well said, when the range of expansion is the same for two engines, one with automatic cut-off and one with a throttling governor, the loss by using the throttling governor to regulate the speed is probably too small to find, except with the very finest tests.

Charles T. Porter is now devoting his energies to the idea of regulating engines by a throttling governor and running the valve with a cam. If the cam can be made to work without noise and irregular action, he believes that the automatic cut-off must give way again to the throttling governor.

The question whether compression is essential to quiet and smooth running in high-speed engines appears to be still unsettled. Mr. Porter has long stood by the principle that the inertia of the reciprocating parts should absorb the steam pressure, and the first Porter engines built by the Southwark Foundry did not use compression. They soon began to thump, however, and had to be altered to use compression. The locomotive is an excellent example of a noiseless high-speed engine, and it uses a great deal of compression. The same thing is true of high-speed electric lighting engines, but it is necessary here with the single valve.

Mr. G. I. Rockwood said that the air pump of the Schichau engine running 225 revolutions per minute was the most astonishing thing he saw at Chicago. One reason why so many independent air pumps are in use is the great trouble experienced with high-speed direct connected air pumps. Referring to high economy, Prof. G. I. Alden has just made a test of a compound engine designed on triple expansion principles, which showed a steam consumption of 12.9 lbs. per HP. hour, whereas ordinary Corliss compounds with this ratio of expansion vary from 14 to 18 lbs.

Mr. C. W. Baker said that a notable recent departure in steam engineering was the application of the inverted vertical marine engine to stationary work. Examples of this type of engine were the Schichau and General Electric engines in Machinery Hall and the Lake Erie engine in the Intramural Ry. power station. The needs of the electric lighting stations have developed this type of engine. No claims for superiority in steam economy are made for it; but it has been adopted to get the greatest power with the smallest floor space, and also to facilitate mounting multipolar dynamos directly on the shaft of the engine. The latest example of large engines of this type is the 2,500-HP. engine in the Elm St. station of the Edison Electric Illuminating Co., of New York city (illustrated and described in last issue of Eng. News). This engine develops 10 HP. per sq. ft. of floor space occupied. Piston valves are used on all cylinders.

Mr. Rockwood said he noticed the remarkable freedom from leakage combined with ease of motion of the piston valve on the Ide engine at the Fair.

Mr. Geo. Hill said that he had had very satisfactory results from piston valves, save in one respect. The valve gets to working along one line and the oil gets from under it and it begins to squeak. It is necessary to give it a slight turn every 10 or 15 minutes. In the use of high-speed engines for electric lighting service it should be the aim to so proportion the engines that they can be kept loaded during most of the time to the most economical point. For example: Three engines of equal size were installed to furnish current for lighting a large office building. It was found that the engines actually developed double the horse power which would normally be required for the work, supposing it to be all done at the most economical point of cut-off. Three engines of different sizes were substituted, and it was found possible to so combine them that the horse power hours developed were only 1¼ the amount which would be required at the most economical loading.

Mr. Frank Ball said that some recent designers of multiple expansion engines had overlooked the fact that other refinements of practice besides expansion in separate cylinders were necessary to high economy. He knew of triple-expansion engines which were running with greater steam consumption than ought to be shown by a good compound.

Mr. Geo. S. Strong said that in talking about electricity as a competitor of the steam locomotive the fact was generally overlooked that a Corliss triple-expansion engine with boiler plant complete costs about ten times as much as a locomotive of similar power. Stationary engines must adopt higher pressures before they can compete with the locomotive.

Mr. J. F. Pankhurst, General Manager of the Globe Iron Works, recently built a power station for a Cleveland electric railway. He put the station on the water front where coal could be unloaded directly from the boats and water for condensation was available. He used Scotch boilers with high pressure, and triple-expansion engines. The entire coal bill of this plant is less than the cost of carting coal and ashes for another station operated by the same company.

Mr. H. H. Suplee said that at the Franklin Institute Electrical Exhibition in 1884 there was a large display of high-speed engines, all of which had developed since the Centennial. The first electric lighting plant in Philadelphia had eight high-speed Porter-Allen engines driving dynamos. There came a reaction, and when this plant was extended a large Corliss engine was installed. The Chicago exhibition shows a new movement toward high speed. The large engines are run at a higher speed and the small high-speed engines are gaining in favor.

Referring to the practice of driving exhaust and steam valves with separate eccentrics, he said that was developed in 1883 by Mr. W. M. Barr, who was then in charge of the designing department of the Atlas Engine Co., of Indianapolis.

Mr. Gus. C. Henning described the Parsons steam turbine (see Eng. News, Feb. 27, 1892, Jan. 12, 1893).

Mr. W. D. Forbes thought that excellent workmanship was one secret of the success of high-speed engines.

Mr. W. T. Bonner said that some years ago a secondary eccentric was used on some 36 × 72-in. engines built for the Milwaukee Cable Ry. by Fraser & Chalmers, the design being originated by Mr. E. T. Sedgholm, Chief Engineer. Some vertical triple-expansion engines of this type sent to the South African diamond mines developed a horse power from 14½ lbs. of feed water.

Mr. J. F. Holloway said that as a matter of history he believed that the first to introduce a high-speed engine was the late Ethan Rogers, when engineer to the Cuyahoga Works, of Cleveland. He built these engines for working mulay sawmills, in which the engine was connected to one end of the shaft and the saw to the other end.

COMING TECHNICAL MEETINGS.

ENGINEERS' CLUB OF PHILADELPHIA.
Jan. 20. Secy., L. F. Rondinella, 1122 Girard St.
SWEDISH ENGINEERS' CLUB.
Jan. 20. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.
CENTRAL RAILWAY CLUB.
Jan. 24. Secy., S. W. Spear, Buffalo, N. Y.
BOSTON SOCIETY OF CIVIL ENGINEERS.
Jan. 24. Secy., S. E. Tinkham, 36 Bromfield St.
ENGINEERS' CLUB OF MINNEAPOLIS.
Feb. 1. Secy., E. Nexsen, 504 Kasota Block.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS
Feb. 2 Secy., E. K. Smoot, 803 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Feb. 2. Secy., O. Von Geldern, 719 Market St., San Francisco.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Feb. 5. Secy., F. Collingwood, 127 East 23d St., New York.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Feb. 5. Secy., C. L. Annan, City Engineer's Office.
ENGINEERS' CLUB OF ST. LOUIS.
Feb. 5. Secy., Arthur Thacher, Odd Fellows' Bldg.
ENGINEERS' SOCIETY OF PHOENIXVILLE.
Feb. 6 Secy., W. Halliburton.
WESTERN SOCIETY OF ENGINEERS.
Feb. 7. Secy., J. W. Weston, Lakeside Bldg., Chicago.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
Feb. 8. Secy., C. H. McLeod, Montreal, P. Q.
ENGINEERING ASSOCIATION OF THE SOUTH.
Feb. 8. Secy., Hunter McDonald, Nashville, Tenn.
ENGINEERS' AND ARCH'TS CLUB OF LOUISVILLE.
Feb. 8. Secy., F. W. Mowbray, Norton Building.
NORTHWESTERN TRACK AND BRIDGE ASSO'N.
Feb. 9. Secy., D. W. Meeker, St. Paul.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Feb. 10. Secy., G. O. Foss, Helena.
ENGINEERS' CLUB OF KANSAS CITY.
Feb. 12. Secy., Waterman Stone, Baird Building.
WISCONSIN POLYTECHNIC SOCIETY.
Feb. 12. Secy., M. F. Schinke, City Hall, Milwaukee.
AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 12, 13. Virginia Beach, Va. Secy., R. W. Raymond, 13 Burling Slip, New York.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
Feb. 13. Secy., F. C. Osborn, Case Library Building.
NORTHWEST RAILROAD CLUB.
Feb. 13. Secy., W. D. Crosman, Ryan Hotel, St. Paul.
NORTHWESTERN SOCIETY OF ENGINEERS.
Feb. 13. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
DENVER SOCIETY OF CIVIL ENGINEERS.
Feb. 13. Secy., F. E. King, Jacobson Block.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Feb. 14. Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
Feb. 14. Secy., F. M. Curtis, P. O. Box 1576, Boston.
AMERICAN SOC. OF MECHANICAL ENGINEERS.
Feb. 14. Secy., F. R. Hutton, 12 W. 31st St., New York.
ENGINEERS' CLUB OF CINCINNATI.
Feb. 15. J. F. Wilson, 24 W. 4th St.
NEW YORK RAILROAD CLUB.
Feb. 15. Secy., John A. Hill, Temple Court.
SCANDINAVIAN ENGINEERING SOC. OF CHICAGO.
Feb. 15. Secy., Howard Berge, 100 Washington St.
ENGINEERS' SOC. OF WESTERN PENNSYLVANIA.
TACOMA SOC. OF ENGINEERS AND ARCHITECTS.
Feb. 16. 201 Washington Building.
Feb. 20. Secy., R. H. Clark, Pittsburg.
WESTERN RAILWAY CLUB.
Feb. 20. Secy., Clement F. Street, Rookery, Chicago.
COLUMBIAN ENGINEERING SOCIETY.
Feb. 20. Secy., F. W. Hart, Washington, D. C.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
Feb. 21. Secy., L. J. Carmalt, Roanoke, Va.
AMERICAN RAILWAY ASSOCIATION.
April 11. Secy., W. F. Allen, 24 Park Place, New York.
SOUTHERN & SOUTHWESTERN RAILWAY CLUB.
April 19. Secy., S. A. Charpiot, Macon, Ga.
MASTER CAR BUILDERS' ASSOCIATION.
June 12, 16. Saratoga, N. Y. Secy., J. W. Cloud, Rookery Building, Chicago.
AMERICAN ASSOC'N OF MASTER MECHANICS.
June 19, 23. Saratoga, N. Y. Secy., Angus Sinclair, Temple Court, New York.

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AND

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ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

We would call the attention of our esteemed contemporary, "The Engineer," of London, to the fact that in failing to give this journal proper credit for a literal reprint of an article on the Neuhausen "Concrete and Iron Highway Bridge," in its issue of Dec. 29, it has probably puzzled, if not deceived, some of its own readers. The expression "our correspondent" is freely used throughout; though it is not made plain that this was a correspondent of Engineering News, and not of "The Engineer." The single and only change in the text is an interpolated credit to this journal for the cuts used, by changing our expression—"As shown in the accompanying illustrations," to—"As shown in the accompanying illustrations from the Engineering News." The expressions "here" and "in this country" found in the article refer to the United States, and not to England, as English readers would be excusable in supposing.

The article by Professor Durand, in another column, seems to us a real contribution to what may be called applied mathematics by furnishing a new form of the well known "Simpson's rule" which is at once much simpler and more accurate. Devices for doing things more accurately by taking more trouble are common enough, but rarely have great utility. Devices which increase accuracy by reducing labor are very uncommon in the beaten paths of elementary mathematics; and moreover, if by chance a man does get upon the track of such an improvement, he does not often, as Professor Durand has done in his rule (F) given elsewhere, push on still further to still greater simplification by what may look to some rigid mathematicians as inadmissible looseness, because he splits the difference between two rigid rules instead of precisely following either, but which is nevertheless a substantial addition to accuracy as well.

Professor Durand almost reduces the old rough method, of merely summing the ordinates and deducting the half-sum of the first and last, to the most accurate form as well. His new rule reduces to this: Determine the mean ordinate by this old rough rule. Then add to it algebraically 1-10 of (half-sum of first and last minus half-sum of the two penultimates). The result is the most probable value of the mean ordinate which is mathematically determinable by any process whatsoever from the ordinates alone. Surely this is a neat result, of which the makers of textbooks at least should, "when found, make a note of."

The statistics of street car changes within the past year quoted from the "Street Railway Journal" in another column, though quite certainly inaccurate in detail, are an interesting further indication of the rapid change which is going on in the substitution of power for animal propulsion of street cars. The reported total mileage of track in the United States has increased within a year from 11,634 to 12,174, or 4.6%, while the total number of cars has increased from 37,274 to 39,509, or 6%. This increase in itself is large, considering the financial status in the past year, indicating a general tendency to doubling the street car mileage every eight or nine years.

The details are still more significant. Even in these dull times 1,000 miles of horse railway, or nearly one-fourth of all that remained, has been changed from horses to electricity, indicating that in about two years more, barely 1,500 miles out of perhaps 14,000 will be using horses. That small remnant will doubtless diminish slowly thereafter, as there are conditions of very light traffic where animals must ever be the most economical. Cable railways have increased very slightly, only 12 miles, and their present mileage is less than 9% of the electric, and their cars only 28%. There seems to us little likelihood that cable railways are destined to increase much hereafter. The surface steam railways have also decidedly decreased (about 10%) and appear to be a vanishing quantity which will persist only in special localities. In the struggle for existence the electric street railway has plainly proved itself the fittest. As recently as 1891 there were four times as many cars operated by horses as by electricity. Now, in but a few months more than two years, the number of horse cars in use is but little more than half what it then was, and the number of electric cars exceeds the horse cars. The amazing rapidity with which this silent revolution is taking place may be better appreciated by a brief historical restrospect.

The introduction of electric railways may be divided with approximate exactness into two periods, that of experiment, prior to 1888, and that of introduction and practical use, during and since 1888. On Jan. 1, 1888, the following lines only were in operation in the United States and Canada:

System.	No.	States.	Miles.	Motors.
Van Depoele	6	Mich., Wis., Pa., Cal., Ont.	25.50	43
Daft	3	Md., N. J., Cal.	11.00	27
Sprague	1	Pa.	4.50	10
Fisher	1	Mich.	3.25	4
Henry	1	Cal.	3.00	9
Short	1	Ohio.	1.00	2
Total	13	8 diff. states.	48.25	95

There had plainly been a beginning made in earnest at that time. The number of different systems and roads in actual operation in widely scattered localities then made it clear that the electric railway in some form had come to stay, yet it was merely a beginning, and at no time previous to the latter half of 1887, when most of the above lines were first opened for business, could it have been asserted as proved that electric railways were a practical success.

This would be at once evident if we were to run over the history of the experimental period, but this has been too often given to make it seem worth while. It may be recorded merely that the first electric cars which were ever run in public view ran in 1883-4 at various fairs and other like occasions, and that the first electric car which ever ran upon a public street as a common carrier ran on July 27, 1884, in Cleveland, O., and was given up as a failure about a year later. This latter was on the Bentley-Knight system, the current being carried in a small wooden conduit between the rails, and further attempts by the Bentley-Knight company were not made till the summer of 1887, when they began the construction of a line at Allegheny City, Pa., which was not opened for traffic until February, 1888, and consequently does not appear in the above table. It was not until after the great advance in electric generating plant which began with the first introduction of electric lighting as a practical system in 1880 that electric motors could be said to be even "in sight" as anything more than a vague dream. The amazing progress since is shown above and in a little item on our news page; noting in addition to this only a few intermediate steps: On Jan. 1, 1889, there were 85 instead of 13 different companies, operating 450 instead of 48 cars. On Jan. 1, 1890, two years later, there were 260 miles of electric railway in 56 principal cities alone. The full United States statistics are not yet out, but we judge that they will show about 800 miles then in operation. In 1880 street railways were regarded as of so little importance that no attempt was made to gather statistics of them for the census, but the entire aggregate did not probably exceed 5,000 to 6,000 miles of track (neither electric nor cable railways had then been dreamt of), whereas now there is over 12,000 miles of track; 7,500 of it electric. Truly the world moves fast.

The fatal rear collision on the Delaware, Lackawanna & Western R. R., near Hoboken, N. J., Jan. 15, in which 11 persons lost their lives, adds another to the long list of disasters due to the inherent defects in the train-order system of handling traffic. The chief cause for surprise to railway men familiar with the circumstances is not that the disaster occurred, but that the company has so long been able to operate this crowded section of tracks without more frequent and fatal collisions. From Hoboken to Newark the Morris & Essex division of the Lackawanna system crosses the Newark meadows, the distance between the two stations being about seven miles. A large part of the traffic is suburban, the road carrying the bulk of the commuters between New York city and Newark, the Oranges, Montclair, Summit and dozens of suburban communities in the New Jersey counties of Essex and Morris. Of course this brings a very heavy traffic on the two tracks across the meadows during the morning and evening hours, and train after train is sent out with very short time intervals between. Only the unceasing vigilance of an experienced and well disciplined force has enabled the managers to crowd trains so close together as they have done without frequent and serious collisions.

One reason for past immunity from accident is that this stretch of track traverses a broad level treeless marsh, and trains can be seen in clear weather when miles away. But heavy fogs are very frequent here, especially during the morning hours, when the tracks are most crowded, and it was in such a fog that the fatal collision of this week occurred. With the possible exception of the New York, New Haven & Hartford, there is no company handling so large a suburban traffic as the Lackawanna out of New York city without the protection of block signals. The company cannot plead poverty as its excuse for longer delaying their introduction, and it is to be hoped that the fearful object lesson of this week will remove whatever obstacles have stood in the way of this much-needed reform.

The American Society of Mechanical Engineers holds fewer meetings than any other of the national engineering societies. The Civil engineers hold meetings twice a month throughout the year, except in July and August, the two principal meetings being the summer convention and the annual meeting, held in January. The Mining engineers hold one annual and two regular meetings. The Electrical engineers, when first organized, followed the practice of the Mining engineers, but since 1886 have held regular monthly meetings. The Mechanical engineers have long followed the practice of concentrating their work in two yearly meetings; but after the Society came into possession of its own house the desirability of more frequent meetings began to be discussed. For one or two years past monthly social gatherings, currently known as "petticoteries," have been held; but these, however delightful to the younger members of the Society, have not met the existing need for more frequent meetings for the discussion of technical subjects. To meet this need a number of members of the Society have re-

cently made arrangements for a series of monthly meetings. The proceedings of the first of these, which was held on Jan. 10, and was very largely attended, are given in another column. It is generally conceded that the chief interest in the meetings of a technical society arises rather from the discussions than the papers read; but unfortunately, the number of papers presented at the semi-annual meetings of the Mechanical engineers is generally such that discussion is in many cases apt to be choked for lack of time. In the coming monthly meetings a single brief paper is to be presented and then nearly two hours will be available for general discussion. The projectors of these meetings hope to make them so interesting and important that non-resident members will endeavor to so time their visits to New York as to be present. An excellent feature is the privilege extended to members to invite friends to the meetings, who may be privileged to take part in the debate by permission of the chairman.

THE MODERN NAVAL STATUS.

Since the close of the Napoleonic wars in 1815 there has been practically no naval fighting in comparison with the almost ceaseless naval wars of the two preceding centuries. In these early wars every seafaring nation played its part, and during them, we may well believe, the art of building and fighting warships was brought to as high a degree of perfection as the arts of that day permitted. In the 78 years since that day there have been bombardments of Sebastopol and Alexandria, one or two contests between (presumably) ill-manned and managed ships in South America and one large ironclad sunk by ramming at Lissa in 1866 (we believe) and a few accidents, like the recent sinking of the "Victoria," which have served as well as naval battles to point a moral. But with these exceptions, practically all the naval fighting of any significance which has occurred in all these years was in our own late war, and in that the chief work of our navy was in humdrum blockading or in attacks on land fortifications. The only two naval battles of any significence were those between the "Monitor" and "Merrimac" and between the "Kearsarge" and "Alabama."

In the meantime, and chiefly since the latter event, all the conditions of naval warfare have been revolutionized several times over; first, by the introduction of steam power as an auxiliary; secondly, by the abandonment of sails and reliance on steam power solely, with its consequent great increase in the possibilities of ramming; thirdly, by the introduction of armor and its continual improvement; fourthly, by the introduction of modern ordnance and rapid fire guns; fifthly, by the invention of high explosives and arms employing them, such as automobile torpedoes; sixthly, by the introduction of electrical and pneumatic methods of handling guns, and doing other work about ship; seventhly, and possibly among the most important in the end, by the introduction of successful and effective range-finders and smokeless powders.

To this long list of revolutionary changes, not a single one of which has been tested in battle, is to be added still another, that with individual exceptions too few to have any significance all the navies of the world are now in the hands of men absolutely without experience in the art which they profess, that of fighting ships. Never before in naval history has there been a time when the higher commanding officers at least were not men of pretty large experience in fighting. Never before in the history of any human art, which we can recall, has there been a time when all its practitioners had for even one generation (still less, two or three) never actually done the things they were trained to do, nor used the tools provided for them to do it with, but had merely "stood by" all their lives, ready for a call which never came.

Under these circumstances, if there is anything which human experience enables us to predict with certainty, it is that there will be some tremendous surprises in the next great naval war (if there ever is one), revealing grave defects both in the ships and in the men. To get a truer idea of the situation, let us suppose that all ocean travel had ceased in 1815-20, but that all nations had felt bound to make great preparations for it by building ships and keeping them in stock against an expected sudden demand. Is it likely that even starting from the excellent vantage ground of the splendid "Liverpool liners" of that day, we should or could have developed from our inner consciousness only such perfect tools for their work as the "Lucania" and "Paris," and have had such vessels in stock for our expected need? Surely not. Rather, the probability is that, if we suppose ocean freight business to have developed in the meantime as it has, in all points in which passenger and freight business are alike, our stock of passenger steamers would have been very good, but in speed and cabin appointments and service and all other needs special to passenger steamers, they would have been wretchedly defective as compared with what they might be and now are.

Such, almost to a certainty, is the present condition of the navies of the world. In the requirements which are alike for fighting and commercial marines they are evidently very good. Among these are speed, strength of hull, quality and power of engines for propulsion, heating and lighting arrangements and the like. So also in navigation and seamanship and in command of their crews, in which naval officers are constantly trained, and which are alike needed on all ships, the naval officers will probably compare most favorably with those of the commercial marine, as they have always done.

But in the needs peculiar to fighting ships, it is probably far otherwise in many details, and notably in two, the maneuvering powers of ships and the capacity of the officers to handle such an intricate mechanical engine as a man-of-war has become. The armament, we may reasonably believe, is pretty well adapted to its requirements, because it is possible to subject this to crucial tests without actual trial in battle, both as to its offensive properties and as to the ease with which it may be disordered by careless and excited men. No doubt serious mistakes of judgment have been made in respect to armament, which war will reveal, but not probably of a general and universal nature.

But in respect to maneuvering powers, it is obvious that since the introduction of steam there have been inherent possibilities for increasing them which so far have not been availed of either in merchant or naval vessels. For merchant vessels this is natural, for they have no need of greater maneuvering powers than they now have and have had from time immemorial. Their errand is peaceful and direct, from port to port; they do not even sail in fleets, still less maneuver, and they aim neither at offense nor defense. The only time when greater maneuvering powers would be at all useful is in getting to dock, and then they would save only a few minutes of time, but neither risk nor money.

On the other hand, naval vessels now have vastly greater need than ever before for the utmost powers of that kind; first, because they go in fleets and are likely to fight with fleets more than ever before; secondly, because ramming is now the most certain and effective weapon of offense, since guns and armor are so nearly at a stand-off, and avoiding ramming the most essential mode of defense; thirdly, because the introduction of steam makes this mode of attack always possible regardless of the weather.

In this last fact we strike a reason why so little effort may have been given to increasing the maneuvering powers of warships. From the days of the triremes until 1850 it was impossible to make the ram a very important weapon, because the only motive power was from wind and sail, whose force and direction could never be counted on, and which could only be managed and directed by the rudder. Merchant vessels got all of this force they could; warships could do no more. Hence, the traditions of centuries pointed to an identity of construction between the two, and on the first advent of steam this tradition was naturally still followed—for how natural it is to man to follow his nose until he bumps it against a post! Twin screws did something both for merchant ships and warships, but otherwise, in all the years since 1850 nothing has been done to increase these maneuvering powers; not by merchant ships, because they have no need; not by naval vessels, because—why? Certainly not because they have no need; for they clearly have the greatest need. Certainly not for lack of possibilities, because the combination of energy always on tap in the hull and a surrounding fluid mass in which to exert it opens all sorts of possibilities.

The result is seen not only in the "Victoria" disaster, but in a variety of prior and subsequent events of the kind, as, for example, if the cable may be believed, in no less than five collisions within two days in the evolutions of the Channel squadron just after the "Victoria" disaster. That disaster was, of course, a pitiful event and one's sympathies go out to all the brave men who were so suddenly swallowed up, and who as individuals behaved so well; but the service as a whole and as distinct from individuals deserves no such sympathy, for there was something inexpressibly ludicrous as well as sad about the whole performance. It revealed a pitiful inaptitude for the duties for which such vessels are supposed to exist. Perhaps no worse than in other services; that we do not say; perhaps not so bad as in all others, but absolutely a very bad state of training and preparation for real war.

For here was an assemblage of the crack ships of the crack fleet of the crack navy of the world, in broad daylight, on a placid summer sea, with neither fog nor current nor wind to confuse, with not even a spectator (still less an enemy) near to disturb the equanimity of any one, and with all the ships in the beginning six cables' length, or nearly a mile (4,320 ft.) apart. An order is given to re-form in another order—no matter what—and not only did the several commanding officers not know enough to "get there," somehow, into the new positions desired, so as to carry out the spirit and aim of the order in safety, but at no time in the process of literally obeying the order before collision was inevitable did they know enough about handling their own vessels to foresee that disaster was otherwise certain and make the slight modifications of course which, until the very end was at hand, would have assured safety!

Unfitness for the exigencies of war can no further go than this; for if such things may happen under these conditions, what is likely to happen in the excitement and confusion of battle, with fog and smoke and personal excitement to confuse; with a greater fear of delaying to execute any order whatsoever, and with every ship of an equal fleet watching for a chance to run some other down?

The one man who was least to blame for this disaster, it seems to us, is he who has been chiefly saddled with it, the dead admiral commanding. If the absent are always wrong, the dead are still more sure to be, and his remorseful exclamation, when he saw the magnitude of the disaster, "It was all my fault," was surely made too much of as excusing the living from blame. For if we may assume to guess what was in his mind in giving the order it was that, if the order could not be literally obeyed, it could in its substance and with the same final result, and that, if his captains did not know enough to secure this result by running some risk of a collision without having one, it was time they did. And he was clearly right. The idea that in peaceful evolutions designed to mimic and prepare for war, vessels whose very purpose is to run every risk in battle must not run any risk at all is too absurd for consideration. What will become of any fleet which cannot execute in safety in battle a maneuver involving some risk of collision if carried out with literal stupidity? In view of the importance of naval efficiency to the dead admiral's country, if the service was in such a state that two ships a mile apart could not meet and pass without running into each other, be the initial orders what they may, it was time the fact was known; and if, as may easily be, it may save the loss of a whole fleet and the national prestige as well, this knowledge was dirt cheap at the price, even of 400 lives and a crack ship. In peace times 400 men seem a good many to die at once, but only 30 years ago such a loss hardly attracted attention in our morning papers.

Now we shall not undertake to point out specifically by what methods it is possible to increase the maneuvering power of warships. We are aware of the very serious difficulties in the way. Beyond a certain size an ordinary rudder is neither useful nor controllable, and at no other point on the ship's

hull can a given resisting or deflecting area produce anything like the effect that the same area in the rudder does. The underlying difficulty is that the ship's hull, being necessarily straight, and having an enormous side resistance against the water, cannot change its direction of motion otherwise than gradually, and this is done with far more ease than in any other way by throwing the stern over (which is what the rudder does) and not by any resistances along the bow or side of the ship. There are, of course, difficulties; it is not as easy as lying to say just how maneuvering powers can be increased, or it would have been done long ago.

Nevertheless, the fact remains that warships have a most vital and urgent need for the utmost maneuvering powers; that warships have in recent years unlimited power on tap within the hull for manipulating appliances to this end, and an unlimited mass of fluid externally on which such power may act; that merchant vessels have no need whatever for maneuvering, but only for directing powers—and that, nevertheless, the warship of to-day is not provided with any other or higher maneuvering powers than such as the needs of merchant service have developed for them and are in contemporaneous use by naval and merchant vessels alike.

In other words, along the lines which are common to naval and merchant service, naval shipbuilding is making most creditable progress—by copying merchant practice with slight modification! Along the still more important line which is special to it naval shipbuilding is making no progress at all, but is still content merely to copy merchant practice, though the needs of the two are most diverse!

When we consider the further fact alluded to at the beginning of this article, that for five or six generations (so to speak) of warships, hardly a single warship on the globe has been actually used in fighting with other ships, it is difficult to believe that naval administrations are not committing a serious error in merely following past precedents and current merchant practice; an error which will be rudely revealed to them by the first shock of war, when it is too late to correct it.

We have left ourself no space in which to speak again of another probable error from a too blind conservatism to which we have before alluded, that, namely, of the training and organization of officers. In early naval days it was not considered necessary that the fighting and commanding officers should be good seamen. The error in that notion was soon seen, and for nearly a century the theory at least of every service has been that every naval officer must be a thorough seaman, whatever else he is; master of all the arts of navigation, of judging of the weather, managing sails and the like. Only prolonged service at sea can bring knowledge to perfection; it is the work of a lifetime. The mechanical progress of the last 30 or 40 years has stripped this old knowledge of all its importance. New and greater agencies have taken the place of wind and weather for controlling the ship. Instead of training the old men or class of men for these new duties, a new class of expert officers has been created and installed to discharge them, and the old class of line officers has sunk down to its old position of two centuries ago—to mere fighting officers, who neither know nor care to know the technical art of managing their own ship, who inwardly despise such knowledge, and who are hence practically mere passengers on their own ship, invested by law with command, but utterly incapable of handling her should any chance disable the three or four men on board who alone know how to do it.

The shock of battle will soon reveal what idiotic folly this is. It is perhaps too much to expect that anything less will suffice to change it; but this general type of organization once cost the French nation its entire navy, and it has cost more navies many ships. It now exists again in every navy, but we may thank our stars that it is probably less so in our service than in any other. In the British service especially, the engineer officers hold what in any rationally organized service would be regarded as an intolerably degraded position both socially and financially, considering the knowledge and qualities they are expected to have.

Nothing but war, as we have said, is likely to awaken the British nation to the folly of this, nor the European nations generally, but if those most guilty of it do not pay for it in bitter humiliation in the next great naval war they will be, indeed, fortunate. We who are not cursed with a social organization favoring such a procedure should see the folly of it in time. Radical changes should not be made too abruptly, but the modern warship is nothing but an e pluribus unum of mechanical engines. The aim should be, therefore, to make every officer in line of promotion an expert engineer who understands this engine, as the first essential, whatever else he is. The line would not lose but gain in dignity thereby, for many reasons. Through no fault of their own, but solely from the progress of events, they are fast becoming an absurdity and an anachronism with their present combination of nominal power and real competency.

LETTERS TO THE EDITOR.

ICE TANKS OF WICKES REFRIGERATOR CARS.

Sir: I should like to bring to the notice of your readers a few points in regard to the construction of the ice tank in the new Wickes refrigerator car, a description of which you gave in your issue of Nov. 16, 1893. I inclose sketches showing the construction of the walls of the old Wickes tank, and that now used in the new car. It will be noticed that the old construction is composed of interlacing ribbons of galvanized iron with U-shaped metal strips inserted at each crossing. The open work interlacing allows the air to pass from every part of the ice receptacle into the air passage or ducts which surround the tank on four sides. There is also a quantity of air cooled by passing down through these ducts or passages, and yet which does not come in direct contact with the ice. This is accomplished by the large cooling surface displayed by the metal basket work and projecting leaves. These projections further act as a moisture collecting medium. In fact, it is this device which makes the Wickes car so dry. The objections to this method of construction are quite outside of its refrigerating qualities. It will be readily seen that the metal basketwork and U-shaped insertions must be woven by hand, and the quantity of iron used is more than double that contained in the surface covered. The numerous layers of impact metal, there being three thicknesses at some points, form convenient pockets for dirt and straw, and corrosion and foul air are the results.

The new tank frame has for its wall long, narrow plates of iron, 7 ins. wide, running the full width of the car. The plates are bent to form angle irons 3 × 4 ins., giving a continuous metal shelf 3 ins. wide, projecting into the air passage. These plates are placed 1 in. apart, one above the other, so that the air passes from the tank in sheets, as it were, instead of through perforations. The metal shelf being continuous, presents a greater moisture collecting surface to the air than the interrupted projections in the old rank. Obviously, the simple, straightforward construction is very much cheaper, less liable to collect dirt and more easily cleaned. At the same time it preserves its excellence as a refrigerating device.

I thought that, perhaps, these facts might be of interest to your readers, as there are 9,000 Wickes cars now in use, or more than one-third the total number of refrigerator cars in the country. If popularity is evidence of merit the devices set forth here may be justly held the most perfect of their kind yet originated.

Very truly yours, Walter H. Wickes.
Gen. Man., Wickes Refrigerator & Car Co.
Chicago, Jan. 2, 1894.

TRANSVERSE TESTS OF CEMENT—CORRECTION.

Sir: Since the publication of our thesis on "Transverse Tests of Cement," Mr. Abbott has received a letter from the Union Akron Cement Co., which it seems desirable to answer through the columns of Engineering News, as we unintentionally made a misstatement therein. We had never used any Akron cement before and were ignorant of the method of manufacture of that particular brand. The cement, both as to time of setting and strength, had every resemblance to Portland cement, and we classed it as such. The following letter has been received from the Union Akron Cement Co.:

"We have read your thesis with pleasure and profit. As we furnished some Akron cement for tests at Dartmouth College, we desire to make a little correction in your paper if you will kindly allow of it. The Akron cement is not Portland cement, but is a natural cement, made in the same manner as the Rosendale cement, from a natural rock. The cement we sent you was the 'Akron (Star Brand) Cement.'"

By classing and comparing this cement with the regular brands of Portland cement we evidently did it an injustice.

Yours truly, E. J. Morrison.
Hanover, N. H., Jan. 8, 1894.

(The injustice referred to of course was in classing the Akron cement as a somewhat inferior Portland cement instead of as a superior natural cement.—Ed.)

A "COLLEGE" WITH DEGREES FOR SALE.

Sir: I inclose a letter received from a firm which seems to have degrees for sale. I have no use for them, having all the degrees I want already. F. H.
Climax, Mich., Jan. 4, 1894.

(The inclosures lead us to wonder if there are any police in Chicago. It is a barefaced offer to sell degrees to any person, male or female, for $30, $5 payable in advance to obtain "the necessary blanks, also the preliminary questions which, if answered satisfactorily, will enable us to decide your fitness for a degree." The circular states barefacedly, moreover, that the college is "chartered and organized for the purpose of conferring degrees upon worthy persons" who are adjudged by it to be "proficient in the arts, sciences and literature." The name, address and management of this interesting institution are as follows, the names being probably fictitious and the "degrees" conferred only by the college itself.

College of Higher Sciences,
1061 Monroe St., Chicago, Ill.
James Russell Price, M. D., Ph. D., LL. D., President.
Andrew J. Swartz, D. C. L., Ph. D., LL. D., Dean.
E. W. Baldwin, Ph. D., LL. B., Vice-President.
John H. Randall, M. D., Ph. D., Secretary.
Geo. O. Cooper, Ph. B., Treasurer.

We have taken measures to see that this "institution," which is probably only another form of the "green goods" game, be called to the attention of the postoffice authorities.—Ed.)

CALCULATING MIDDLE AREAS OF PRISMOIDS.

Sir: Will you oblige me by stating in as simple form as possible what is the correct method of finding the middle areas of prismoids by calculation; I mean, of course, with accuracy? Yours truly, R. L. R.
Glenville, W. Va., May 22, 1893.

(We presume our correspondent refers to earthwork prismoids between more or less irregular cross-sections. Otherwise there is no particular difficulty.

When the end sections are irregular there is no absolutely correct method, for the simple reason that the end sections only do not necessarily define the form of the intermediate sections. In a sense, this is true of all field notes of cross-sections, but whenever the number of surface levels is the same in the two end sections, whatever their number, it is customary (and most accurate) to assume that the surface is a right line between each pair of points on the end sections and that the surface between is a hyperbolic paraboloid, which means that a section parallel either with the center line or the end sections generates a right line.

Under this assumption the half-sum of the horizontal and vertical co-ordinates of corresponding points on the end sections gives the co-ordinates of the corresponding point for the mid-section. When, as often happens, the number of given surface points is greater in one section than the other, the only possible assumption is that three triangular areas terminate at the extra point, and the mid-section, when computed, will, under this assumption, have still more points defined than either of the end sections; but if the end sections were taken in the field without special reference to the mid-section, there is necessarily no assurance that the mid-section when thus computed will approximate very closely to the actual section.—Ed.)

THE TRAIN STAFF SYSTEM AND THE ELECTRO-PNEUMATIC LOCKING PLANT.

Among the most interesting and important improvements in signal and interlocking plants, exhibited at the World's Columbian Exposition, were the Webb & Thompson electric train staff machine and Tyer electric train tablet machine, exhibited by the Johnson Railway Signal Co., of Rahway, N. J., and the electro-pneumatic locking machine of the Union Switch & Signal Co., of Swissvale, Pa. These were briefly referred to in our report on the track equipment exhibits (Eng. News, Sept. 14, 1893) and special attention was

called to them in a paper presented at the last annual meeting of the American Society of Railway Superintendents, by Mr. W. L. Derr, Division Superintendent of the New York, Lake Erie & Western R. R. The train staff and train tablet machines, both English inventions, represent the development of one of the oldest systems of block working, and we agree with Mr. Derr's views as to the important advantages offered by these machines for safe and economical block working on single track, although the necessity of slowing down at every tower to take and deliver the staff

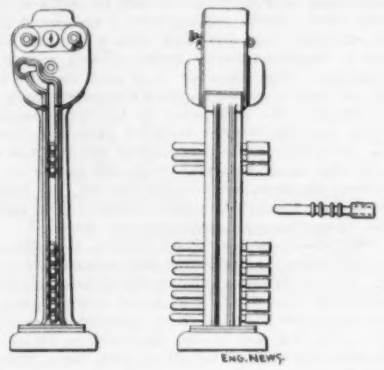

Fig. 1. Webb & Thompson Train-Staff Machine.

or tablet would be an objection on lines running fast through trains, an objection which is avoided by the Mozier block signal system (Eng. News, May 11, 1893), which requires but a very inexpensive equipment. Neither the train staff nor train tablet machine has yet been used in this country. The Webb & Thompson train staff machine is the invention of two engineers of the London & Northwestern Ry., and was described and illustrated in our issue of March 29, 1890, and Wise's train staff, made by MacKenzie & Holland, of England, was described and illustrated in our issue of June 23, 1888. The electro-pneumatic interlocking machine is a specialty of the Union Switch & Signal Co., of Swissvale, Pa., and we are indebted to that company for further details than were given in Mr. Derr's paper.

The Webb & Thompson train staff machine and the Tyer train tablet machine are both designed for single track blocking, and are worked mechanically except that they are unlocked by electricity. Either system requires two machines for each block station, one for each block, the machines at both ends of the block being connected by an electric circuit. In operating with these machines the engineman must carry a staff or tablet, as the case may be. Being the chief agent in the movement of a train, he is made the key to the whole situation. The train staff machine consists of an iron pillar with a vertical slot through nearly its entire length, in which is a supply of staves. The head of the machine, called the locking case, contains the electrical apparatus. Only one staff at a time can be withdrawn from the two machines governing a block, and then only with the consent of the signalman at the receiving station who alone controls the staves at the sending station, those staves being beyond the control of the signalman at the latter station. Another staff cannot be removed from either machine until the one already out is restored at either end of the block. Thus, when a staff has been taken out at station A, another cannot be taken out at station B, nor can a second staff be taken out at A until the staff previously withdrawn has been restored in the machine at A or B. Each block has its peculiar form of staff, and the staves for one block cannot be replaced in machines belonging to another block. A staff can, however, be replaced in a machine without previous communication with the opposite end of the block. Communication between block stations is effected by means of electric bells. In practice each block station should be provided with ordinary outdoor semaphore signals.

To illustrate the method of working the staff machine, let A and B represent two block stations. Before starting a train from A toward B the situation with reference to the block is cleared up by means of the bell code. If the block is clear of trains and obstructions, B, when asked, unlocks A's machine by holding down his key (or "plunging"), which allows A to withdraw one staff. This staff is given to the engineman, who, on arrival at B hands it over to the signalman to place in his machine. As the machine at either end of block cannot be unlocked while the engineman has the staff it is, of course, impossible, to furnish a staff for another train until the first train has cleared the block. The London & Northwestern Ry. Co., of England, makes a Webb & Thompson machine so arranged that more than one train can be sent into a block in the same direction at one time. This machine has a special staff contained in a separate slot. The special staff is used in connection with six metal train tickets, providing for the movement of seven trains. It is a key to unlock a box containing the train tickets, and is withdrawn from the machine in same manner as the ordinary staves. After unlocking the box and taking out all the tickets the box is again locked. The tickets are given out to trains, permitting the trains to enter the block. The last train takes the staff and any remaining tickets. After all the tickets and the special staff are delivered at either end of block the tickets are locked up and staff placed in the machine. The line is then again clear. The machine is so arranged that the special staff cannot be restored until all the tickets have been locked up in one box. When this special staff is withdrawn no other staff can be removed, and vice versa. There is but one special staff and set of tickets for each block and they must always be in one machine. Both the ordinary and special staves have keys to unlock switches, and are so arranged that they cannot be withdrawn from the switch lock without locking the switch for the main track.

The train tablet machine is operated similarly to

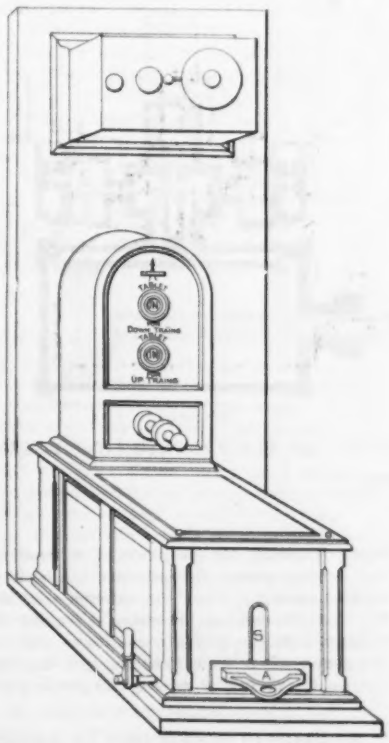

Fig. 2. Tyers Electric Train Tablet Machine.

the train staff machine, but metal tablets are used instead of staves, the tablet being simply a train staff in another form. These two instruments are so nearly alike in their operations that it is not necessary to go into details with them both. Besides being absolute blocking instruments these machines are specially adapted to the protection of drawbridges and junctions. A general view of the train staff machine is shown in Fig. 1, and a view of the train tablet machine in Fig. 2, in which A is the slot for withdrawing the tablets, and S is the slot through which the tablets are replaced.

In a letter to us Mr. Derr states that besides using the train staff and tablet machines for the protection of drawbridges and junctions, as suggested in his paper, he would propose to use them at railway grade crossings, in the following manner: Two machines to be placed on each line (say, A-B and C-D), one each way from the crossing, and two machines (one for each track) are placed in the signal tower at the crossing. All these machines to be electrically interlocked so that no staff can be removed from any of the four outlying machines until permission has been given

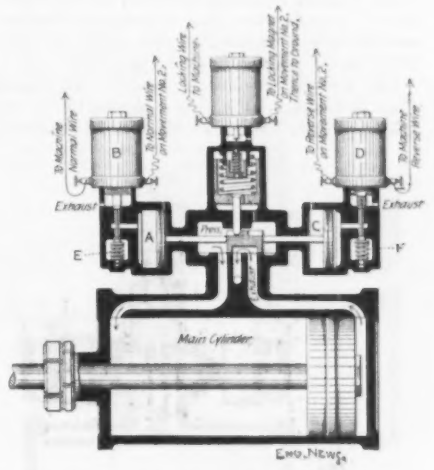

Fig. 3. Electrically Controlled Valve of Electro-Pneumatic Locking Machine.

by the signalman at the central tower, and also so that upon the removal of a staff from any one outlying machine, say, A, no other staff can be removed therefrom, nor can any staff be removed from B, C or D. This arrangement requires but one signalman on duty at a time, as the trainmen can take the staves from the outlying machines. Suppose a train to be at A, on line A-B; if it is all right to let it cross C-D the signalman at the tower indicates it by giving the trainmen permission to take a staff from the machine at A, and then lowering the home signal to "track clear." One of the trainmen takes the staff, stations himself on the rear of the train and hands the staff to the signalman while passing the tower. The signalman then replaces the staff in the machine, thus setting all the machines in their normal condition. If a second train arrived at A, it would be impossible to withdraw a second staff until the first had been set in the machine by the signalman. The machines could be so arranged that the trainmen

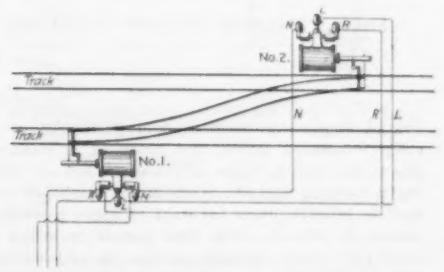

Fig. 4. Crossover with Electro-Pneumatic Locking Machine.

would have to hold the home signal at clear by using the staff, and this, Mr. Derr thinks, would make a doubly safe arrangement.

In the pneumatic interlocking machine of the Union Switch & Signal Co. some of the newer and more interesting features are as follows: 1, the use of electrically controlled valves at switch movements; 2, the application of storage batteries instead of gravity cells for furnishing currents to control its switches and signals; 3, the application of the Saxby & Farmer improved locking

(half the usual size). The use of electric valves permits the abandonment of all pipes leading to the signal tower, resulting in much economy and facility in operation and maintenance. The towers, signals and switches are now connected only by electric wires, while in the original machines two pipes ran from each switch lever in the tower to the switch on the ground. The use of storrage batteries permits a closer regulation of quantity and pressure of current, and results in a considerable economy in cost of operation. The application of the Saxby & Farmer improved locking to the pneumatic machine permits the closest and most accurate interlocking of levers and dispenses with a large amount of costly electrical work in the machine. The Stewart Ave. crossing at Chicago, described and illustrated in our issue of Nov. 16, 1893, is equipped with this apparatus.

The electric pneumatic machine is shown in Figs. 3, 4 and 5. Fig. 3 is a section of the electrically controlled valve in its normal position, and which is attached the magnet B, and applies the pressure to the small cylinder C, to which is attached the magnet D. This results in the shifting of the slide valve. In the fourth position the whole mechanism is shown exactly in the reverse position from that exhibited in the first or normal position, with the exception that in each case the locking magnet is discharged. The pressure is constant in the chambers E and F, and in the slide valve chamber.

It will be seen that the pressure in the main cylinder is applied directly from the chamber in which is contained the slide valve, and that the exhaust takes place in the opening midway of the apparatus and below the slide valve. The lock is a check on the action of the small cylinders which shift the slide valve, since even though they may be excited and discharged alternately, or together, no change will take place in the position of the valve or the piston in the main cylinder unless the locking magnet has been previously excited. Through the presence of a small hole in the locking piston the pressure on both sides is rapidly equalized when the exhaust port is closed, but since the hole in the piston is smaller than the exhaust port the pressure continues greater under the piston when the exhaust is open and thus acts against the spring by raising the piston and lock.

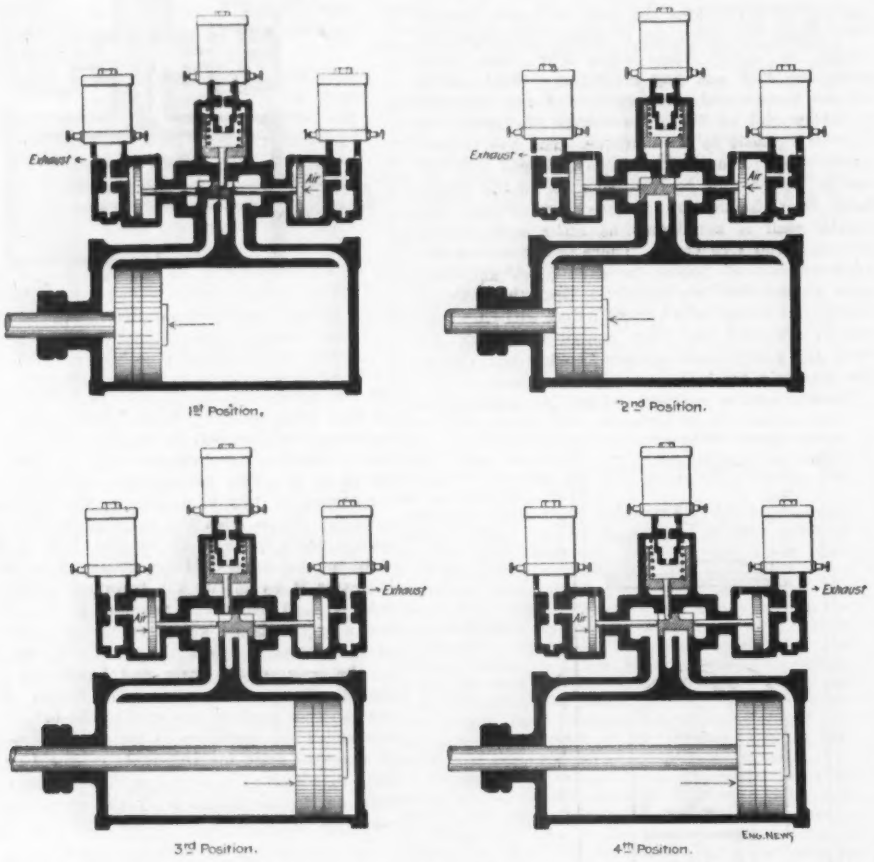

FIG. 5. DIAGRAM SHOWING POSITIONS OF VALVES OF ELECTRO-PNEUMATIC LOCKING MACHINE.

Fig. 4 shows the location and wiring of electrically controlled valves for working a crossover. There are four periods in the operation of throwing a switch, and the positions of the slide valve and its relative parts for each of these periods are shown in Fig. 5. The first period is when the lever rests in its normal position, at which time it will be seen that the magnet on the left hand is excited, the center magnet and the magnet on the right are discharged, the locking pin is engaged with the slide valve, and the pressure is on the left-hand surface of the main piston head. The second position is when the lever is thrown slightly to the right. At this time the normal machine magnet remains excited, but the locking magnet is also excited which opens the small exhaust port above the lock cylinder and permits the pressure which remains below the locking piston to act upon it. In the third position the normal machine magnet has been discharged, the locking magnet remains excited and the reversed machine magnet has become excited. This operation permits the escape of the pressure in the small cylinder A, to

SEWAGE PURIFICATION IN AMERICA.

(Continued from p. 28.)

The Enlarged Chemical Precipitation Plant at Worcester, Mass.

In our issue of Jan. 11 the plan and mode of operation of these works was described in detail, with the exception of the stop boards and their lift, the disposition of the sludge, including the turbine, air compressor and ejector, and the electric lighting plant.

As previously stated, the effluent or purified sewage is conducted through two weirs to a penstock 7½ ft. square, in which is a 21-in. turbine. These features of the works are described by Mr. McClure, as follows:*

The walls of the penstock (see the cross-section, Fig. 94) are built of rubble masonry 3 ft. in thickness, with an arched discharge into the common channel leading to the river. The pit is paved with selected street blocks laid in Portland cement mortar, and the floor composed of 4-in. I-beams covered with 2-in. tongue and groove plank caulked with oakum in the wall joints. Above and inclosing the wheel pit a brick building 32 ft. 2 ins. in length and 11 ft. 7 ins. in width accommodates the air-compressing plant for the sludge disposal, together with a dynamo for lighting purposes. Attached to the driving pulleys of the wheel is a 14-in. double belt Rand air compressor, with 12-in. stroke feeding into a receiver 5 ft. 9 ins. in diameter, and 9 ft. high, from which the air pipe, 4 ins. in diameter, passes below ground to the ejector chamber. This chamber was sunk about 15 ft. below the surface of the swamp and for quite a depth through quicksand. The foundation is Rosendale cement concrete, and the circular walls of brick were built with an inner core of Portland cement and the floor finished with the same material. From the end of the arched subway an 18-in. brick sewer (see Fig. 94) conveys the sludge to a manhole where connection is made with the 12-in. iron pipe leading to the ejector.

The Shone ejector, which is here used for disposal of the sludge, has proved a very satisfactory appliance. Its estimated capacity is 35,000 gallons per hour, and in actual trial it has discharged nearly 50,000 gallons during the 60 minutes. It is operated under air pressure of 15 lbs. per sq. in., and with a lift of 13½ ft. delivers the sludge through a 12-in. force main to the pits.*

To illustrate the operation, suppose some one of the basins requires cleaning. The sewage will be carried past the basin in question, until the sewage in the

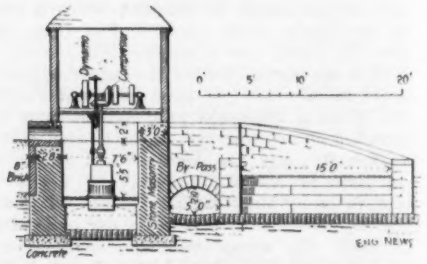

Fig. 93. Section Through Turbine House at Penstock.

tank deposits its sludge and becomes thoroughly clear. The liquid is then discharged through the movable pipe described, leaving the sludge to be disposed of. The sludge gate (Fig. 95) is then opened and the deposit starts on its course through the arched subway to the ejector. In the meantime the water wheel is put into operation and has stored an amount of air in the accumulator ready for its work. As the ejector is filled with the sludge the air valve attached is automatically relieved and the inrushing air causes the sludge to be ejected. After the discharge takes place the air valve is closed, and as the pressure is removed the sludge again fills the ejector, during which time another portion of air has been stored and the process goes on until the deposit is disposed of. To make the wheel self-operative, the gate is opened sufficiently to run the air compressor to the required pressure of 15 lbs., at which point the wheel revolves very slowly, but as soon as the air is relieved in the accumulator the wheel instantly begins further compression and has again slowed down before the amount of air stored is needed.

The sludge deposits being removed in the daytime leaves the wheel available for the incandescent system of lighting at night, by the aid of which the chemical tests and other work about the basins are conducted. The plant consists of a 110-volt dynamo, with distribution for 120 lamps. About the basins are placed 60 lamps (Fig. 96, p. 57), most of which are 16 c. p. each, with an equal number distributed about the buildings. A proper switchboard controls the different sections that are lighted as desired.

In its passage through the basins the sewage is controlled by stop planks (Fig. 97, p. 57), so arranged that one or any number of basins may be separated and the deposit removed whenever necessary. The stop planks are supplied with a device for lifting them, which consists of a 1½-in. shaft placed above the planks, from which they are hung by iron straps. A gear 4 ins. in diameter is keyed to each

* From the forthcoming report of Mr. F. A. McClure, City Engineer of Worcester. Views of the turbine and ejector houses were shown in our issue of Jan. 11 by Figs. 91 and 92, reproduced from photographs.

(* For illustrated description of Shone ejector, see Eng. News, March 23, 1893.—Ed.).

end of the shaft, which operates in vertical standards 2 ft. in height. The shaft at one end is faced to receive a crank, and a winding motion lifts the shaft with attached plank. The bottom and sides of the planks are shod with iron straps operating in grooves, and so arranged that they may be swung clear at their extreme height.

The original works were started up June 25, 1890, but until the enlarged plant was put in operation on July 15, 1893, only a portion of the sewage was treated. At first the amount purified was about 3,000,000 gallons per day. How long this rate was continued is not stated, but, beginning with June 19, 1891, about 6,000,000 gallons were treated for some time. This was above the capacity of the plant, but it was thought advisable

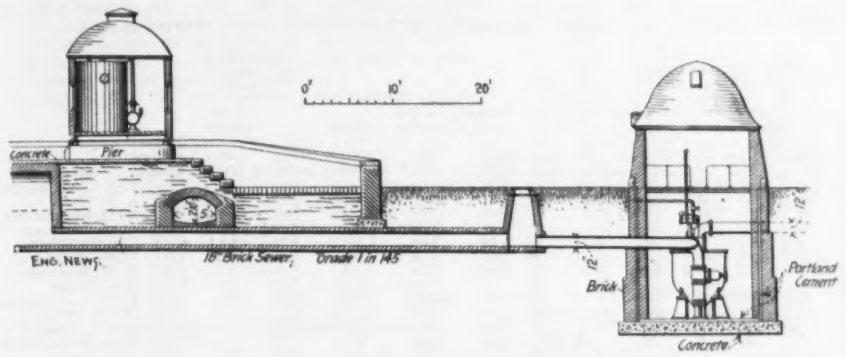

FIG. 94. SECTION THROUGH TURBINE AND EJECTOR HOUSES.

to handle the larger amount even at the sacrifice of the completeness of the treatment. In 1892 both the work of enlarging the plant and experiments in connection with its operation interfered with the treatment. For all these reasons comparisons of the work by years should be made with allowances, although some of the general results may have been but little affected. The main figures regarding the operation of the precipitation works for the three full years since it was put in use are as follows:

	Year ending Nov. 30. 1891.	1892.	1893.
Sewage treated, galls.	1,399,000,000	1,000,776,000	1,795 000,000
Sludge remov'd, galls.	22,042,000	11,601,000	19,700,000
Total solids removed, net tons	1,230	751	2,360
Lime used:			
Total, net tons	758	454	1,105
Lbs per million galls.	1,084	907	1,231
Grains per gallon	7 6	6.3	8.6
Sulphate of alumina used:			
Total, net tons	64.645	None	None
Lbs. per million galls.	92	None	None
Grains per gallon	0.65	None	None

Some further facts regarding sludge disposal and the chemical results obtained and the effect of the purification plant upon the Blackstone River will be given in another issue.

WATER WASTE PREVENTION, OR INCREASED PUMPING CAPACITY.

A thorough investigation of the consumption and waste of water in a large number of American cities was made last year by Mr. Henry S. Maddock, Commissioner of Public Works, of Evanston, Ill. Through an arrangement made with Mr. Maddock the results of his investigations, including the original reports from outside cities, have come into our hands and will be given nearly in full in these columns. First will be considered replies to circulars sent out by Mr. Maddock, requesting information regarding the pumping capacity, consumption and waste of water and the use and ownership of meters. Over 70 replies were received to the 200 circulars sent out, 44 of which were from works owned by cities and 27 from private works. Mr. Maddock brought together in a large table the information thus secured and from that table the accompanying one has been prepared. Some of the omissions from the original table are given in the text, together with additional matter from the reports.

Mr. Maddock states that the general opinion among the water-works officials who made these reports seems to be as follows:

(1) Unrestricted use should not be allowed.
(2) Waste should be prevented by meters.
(3) The meters will reduce the cost of operating the water-works.
(4) The city should own and control the meters.
(5) All consumers should be metered.

Some of the answers given appear to be a little contradictory as to just what measures should be taken to suppress waste and there is a difference of opinion as to how far such measures should be carried, but all agree that waste must be checked and that meters should be used, at least for large consumers. A majority of the works seem to favor both house to house inspection and the use of meters; but about 25 cities, of 66 expressing themselves on the point to be mentioned, would put meters only on large consumers. The majority of those reporting believe that the water-works should own and control the meter, but a goodly number prefer ownership by consumers with control by the works. Here also there are seeming contradictions in the replies, but most of the seeming contradictions in the table are explained in the remarks given further on.

In general the pump capacity is well above the maximum pumpage. There is a wide variation between the daily maximum winter and summer pumpage and the average daily consumption per capita, some of the highest figures, ranged in order of average daily consumption in gallons per capita, with percentage of taps metered added, being as follows:

	Ave. for year.	Maximum pumpage. Summer.	Winter.	P. c. taps Metered
Schenectady, N. Y.	386	361	409	0.5
Oshkosh, Wis.	320	192	470	2.3
Eau Claire, Wis	298	241	483	1.6
Camden, N. J.	238	204	288	1.6
Bay City, Mich	200	270	265	23 6
Joliet, Ill	...	400	416	2.1
Evanston, Ill.	140	167	292	6.0

One point not included in the table is the opinion regarding the relative cost of a meter system and the extra expense of providing and operating a pumping plant to supply water for waste. Nearly all the cities reporting on this point thought that the greatest economy would lie in the meter system. Extra pumping, extra mains, and increased cost of fire protection through low pressures should also be taken into account in this connection.

Many of the officials who replied to the circulars gave their opinions or experiences at greater or less length, either in answer to the questions, or as additional suggestions. The most interesting and suggestive of these are presented below, in the same order as is observed in the table, preceded by the name of the city and of the person who reported for that city:

Detroit, Mich., L. N. Case, Secretary: I would commence (placing meters) on large consumers and users of indefinite quantities (of water), such as breweries, livery stables, dye houses, laundries, etc., taking factories next, then large stores and business places and finally families.

The expense (of unlimited consumption or waste) is not alone for pumps and boilers, but for increased force mains as well, and to a much larger extent, as far as dollars and cents are concerned, than for pumps and boilers or for increased operating expenses.

I think after you have studied up our experience, as illustrated in my report (annual for 1892), you will be perfectly satisfied as to the necessity, the justice and profit of introducing meters.

Louisville, Ky., Chas. Hermany, Chief Engineer and Superintendent: Conduct the business of supplying water to a community upon business principles, totally distinct from charity and patriotism or politics, for which, or to hide which, charity and patriotism are often plead.

Providence, R. I., Robt. E. Smith, Commissioner of Public Works, per W. F. S.: As an unrestricted use of water would also require additional storage capacity and increased size of main and distributing pipes, in addition to the expense mentioned above (interest on pumping plant and cost of operation), it is believed in this city to be economy to require the use of meters.

Camden, N. J., Wm. W. Mines, Chief Engineer: Our city is in the same condition as yours. I would recommend self-closing faucets in private houses.

Lynn, Mass., Jno. C. Haskell, Superintendent: In the absence of meters should have close inspection. A complete use of meters would, in my opinion, be best in any water-works.

Los Angeles, Cal., Wm. McHolland, Superintendent: You omit in your enumeration the increased pipe capacity necessary to supply the waste. A wise application of meters is the cheapest, or even on a gravity system. Prevent waste at whatever cost at first. It will be found easier, after a year of rigid discipline, to control the wastefully inclined.

Springfield, Mass., J. C. Hancock, Superintendent: I

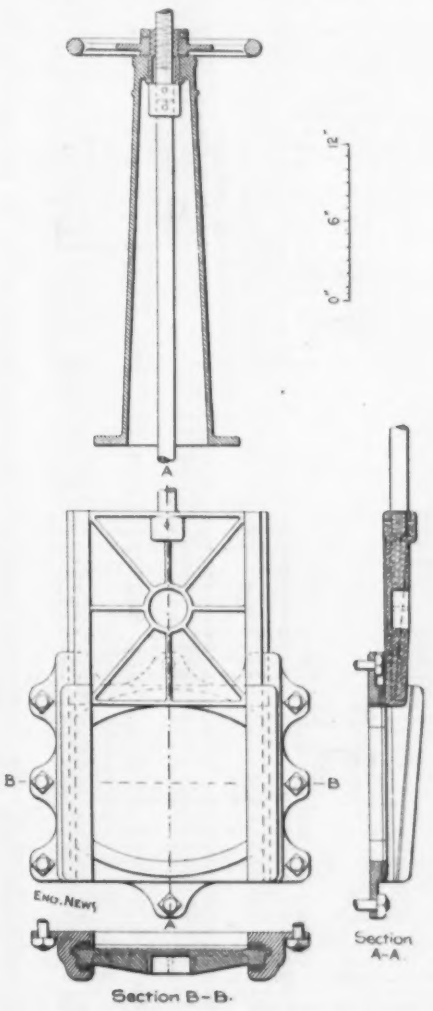

Fig. 95. Sludge Gate on Main Drain.

believe in metering all consumers. The interest on money invested in meters would be less than that invested in pumps.

The time is soon coming when all services will have to be metered. It is the only proper way to sell water.

Utica, N. Y., C. W. Pratt, Superintendent: We find meters good to keep up the pressure. We use meters on any premises having water closets, as well as on large consumers. Probably in proportion to what they pay small consumers waste as much or more than large ones.

There is no injustice to consumers in making them pay for what they use or waste and after a consumer has paid a bill or two by meter or leaky fixtures you will not have to give him a chromo to induce him to hire a plumber.

We depend on reservoirs and can't afford extravagant waste. You, with unlimited supply, can place your rates as low as you can afford (by meter) and still get income enough from half the water now pumped.

Savannah, Ga., Jas. Manning, Superintendent: In cities where the growth has stopped, and there is an ample supply of water, no efforts need be made to prevent waste, but under other circumstances all means should be employed to stop waste.

Peoria, Ill., D. H. Maury, Jr., Superintendent: Meters prevent waste in a manner that no inspection could accomplish. They at first reduce consumption greatly, and therefore revenues, but they soon cease to be noticed by consumers, who become careless, and the bills increase once more. I should, as a general plan, thoroughly recommend you to use meters first, from what I can learn of your conditions, and not to increase your plant until you have tried meters. You know that waste may be increased indefinitely, and if your waste is not checked you may find yourself just as unable to keep up with your water consumption after purchasing additional pumps as at present.

New Bedford, Mass., R. C. P. Coggeshall, Superintendent: I would not put meters in houses at city's expense when the fixtures are carefully looked after and the inspector does not find leaks.

Sioux City, Ia., Phil Carlin, Superintendent: I consider money invested in meters well spent. At least I find it so here.

Covington, Ky., W. H. Glore, Superintendent: Consumer should pay for meter in meter rents. It is only a question of a short time before all our taps will be metered.

Youngstown, O., W. S. Hamilton, Superintendent: Money put into meters is the only way to prevent waste and as a matter of economy, is the best investment a water-works can make. By this course you save pumping machinery, as well as the mains and running expenses.

Yonkers, N. Y., Jos. Lockwood, Superintendent: I would advise use of meters in all cases, except perhaps on an unlimited gravity supply. Our pumping plant would not now be sufficient if we did not have the meter system.

Quincy, Ill., D. R. Gwinn, Superintendent: We do not find that meters on dwellings pay, especially where fixtures are modern.

Mobile, Ala., A. W. MacCullum, General Superintendent: Inspection first, then meters where necessary.

Elmira, N. Y., J. M. Diven, Superintendent: A full meter system is probably the only way to prevent waste and the only suitable way to charge for water.

Bay City, Mich., E. L. Dunbar, Superintendent: Meter all consumers, the city to own and control the meter and charge a minimum rate sufficient to cover interest, repairs and monthly inspection.

Davenport, Ia., T. N. Hooper, Superintendent: Would meter all water takers if an equitable minimum rate could be established by ordinance.

Canton, O., L. B. Obliger, Superintendent: We would not permit waste under any consideration, and would only recommend meters for large consumers or in places where you cannot watch them. We find the best way to prevent the waste of water is to keep a man on the go all the time looking after leaks or waste of water in any form.

Birmingham, Ala., W. J. Milner, Superintendent: Meters are the only effective remedy, and they are very troublesome and cause much complaint on part of consumers.

Macon, Ga., A. E. Boardman, President: I would put in meters and make a minimum price per capita so as to insure enough use to flush drains and sewers. Waste means not only increase of pumping machinery, but early increase in capacity of mains and diminution of pressure.

Burlington, Ia., Chas. Hood, Superintendent: We are putting in a filter plant and expect to use meters pretty extensively the coming season. We own and control our meters and charge a rent of 40 cts., with monthly bill, for all meters, to and including 2-in. and all over, $1 per month.

Montgomery, Ala., Capital City Water Co.: (Ownership of meter) depends upon whether cost and maintenance is figured when making the rates for water charges.

Oswego, N. Y., T. H. Bennett, Superintendent: If water is all pumped by steam and filtered I would meter every service. We employ an inspector who makes house and building inspection twice a year. Since this was done we are pumping 400,000 to 500,000 gallons of water per day less. We also meter all public places and all manufactories.

Meriden, Conn., H. L. Schleiter, Superintendent: Our rule is to lease it optional with the consumer to pay for the meters, or the city will furnish them and charge the consumer 10% per annum on the cost of the same. We do not use meters where the consumption amounts to less than $10 per annum.

Lexington, Ky., S. A. Charles, Superintendent: The

STATISTICS OF CONSUMPTION OF WATER, PREVENTION OF WASTE AND PUMPING CAPACITY OF 72 CITIES OF THE UNITED STATES.

City and state.	Population. 1890.	1893.	P. c. not using water.	Number of Taps.	Meters.	Is all water pumped?	Est. dy. cap. pumps	Max. dy. pumpage* in million galls. during Summer. Total.	Summer. Per cap.	Winter. Total.	Winter. Per cap.	Av. dy. consumption during year. Total million galls.	Per cap. gallons.	Would you prevent waste by Inspectors?	Meters?	Favorful meter system?‡	Ownership and control of meter. Entirely in city?	Consumer own. city control?	Owner ship of works.	Report by
Brooklyn, N. Y.	806,343	900,000	..	96,251	3,000	Yes	81	80	89	76	84	67.5	75	Yes	Large users	Large	Yes	....	City	Van Brunt Bergen.
Detroit, Mich.	205,876	257,000	..	47,281	2,096	Yes	80	47	183	49	190	33.6	133	No	Yes	Large	Yes	No	City	L. N. Case.
Milwaukee, Wis.	204,468	245,000	25	25,370	10,300	Yes	48	30	188	28.5	179	24.1	151	Yes	Yes	Large	No	Yes	City	G. H. Benzenberg.
Louisville, Ky.	161,129	195,000	30	15,350	1,138	Yes	30	16	117	18	131	13	96	Yes	Yes	No	Yes	No	City	Chas. Hermany.
St. Paul, Minn.	133,156	150,000	50	13,000	700	¼	12	5.5	73	2.7	36	3	40	Yes	Yes	Large	Yes	No	City	Jno. Caulfield.
Providence, R. I.	132,146	150,000	..	16,997	11,464	Yes	20	13.6	90	11	73	8	53	Yes†	Yes	Yes	No	Yes	City	Robt. E. Smith.
Syracuse, N. Y.	88,143	105,000	60	3,578	862	¼	16	6.1	145	5.8	138	4.9	117	Yes†	Yes	All	Yes	Yes	Co.	E. N. Westcott.
Nashville, Tenn.	76 168	80,0 0	..	9,000	1,300	Yes	30	....	....	....	....	13	162	....	Yes	Yes	Yes	Yes	City	Geo. Reyer.
Grand Rapids, Mich.	60,282	90,000	..	6,000	425	Yes	23	11	122	9	100	7	78	Yes	Large	Large	Yes	No	City	Fred A. Twamley.
Camden, N. J.	58,313	61,146	2	9,432	147	Yes	18	17	288	12	204	14	238	Yes	Yes	Large	Yes	....	City	W. W. Mines.
Lynn, Mass.	55,127	67,000	..	10,148	494	Yes	15	4.9	73	4.5	67	3.5	52	Yes†	Yes	All	Yes	....	City	Jno. C. Haskell.
Los Angeles, Cal.	50,395	70,000	15	12,500	200	No	4	2.1	35	1	17	.075	12	Yes	Yes	Yes	Yes	...	Co.	Wm. Mulholland.
Hartford, Conn.	53 230	62,000	..	11,050	435	No	..	....	...	....	...	6	97	No	Yes	All	Yes	No	City	Ezra Clark.
Springfield, Mass.	44,179	.....	..	.....	.....	...	...	...	...	...	...	.....	...	Yes	Yes	All	Yes	....	City	J. C. Hancock.
Manchester, N. H.	44,126	52,000	10	4,300	2,000	Yes	10	3	64	2.5	53	.....	..	Yes	Yes	Large	Yes	No	City	C. K. Walker.
Utica, N. Y.	44,009	50,000	40	4,300	3,600	No	..	....	...	....	...	3	100	No	Yes	Yes	Yes	...	Co.	C. W. Pratt.
Savannah, Ga.	43 189	52,000	..	4,000	3	Yes	10	....	...	....	...	7	135	Yes	Yes	All	Yes	No	City	Jas. Manning.
Seattle, Wash.	42,837	60,000	20	8,000	375	Yes	12	8	166	6	125	7	146	Yes	Yes	Large	Yes	Yes	Co.	R. H. Culligan.
Peoria, Ill.	41,024	50,000	70	2,580	1,143	Yes	21	3.3	220	2.5	166	2.4	160	Yes	Yes	Yes	Yes	....	City	D. H. Maury, Jr.
New Bedford, Mass.	40,733	50,000	10	7,134	144	Yes	15	6.5	144	6 5	144	4.3	95	Yes	Yes	No	Yes	....	City	R. P. C. Coggeshall.
Sioux City, Ia.	37,806	40,000	65	3,200	250	Yes	4	2.3	164	2	143	2	143	No	Yes	Yes	Yes	....	City	Phil Carlin.
San Antonio, Tex.	37,673	40,000	..	6,600	40	No	9	6	150	3	75	.....	...	Yes	Yes	.....	Yes	....	Co.	J. Ulrich.
Covington, Ky.	37,371	.....	..	3,400	700	Yes	10	2.3	62	1.9	51	.....	...	Yes	Yes	Yes	Yes	....	City	W. H. Glore.
Tacoma, Wash.	36,006	60,000	40	3,500	300	No	8	5.5	153	5.5	153	4.5	125	No	Yes	Yes	Yes	No	Co.	C. B. Hurley.
Binghamton, N. Y.	35,005	38,000	25	.....	400	Yes	18	3 8	133	3.7	130	3.7	130	No	Yes	Large	Yes	No	City	Jno. Anderson.
Youngstown, O.	33,200	38,000	65	3,200	200	Yes	8	3	225	2.1	158	.....	...	Yes	Yes	All	Yes	....	City	W. S. Hamilton.
Yonkers, N. Y.	32,033	35,000	10	3,200	3,200	Yes	6	2 4	76	2.1	68	2.2	70	No	Yes•	Yes	Yes	..	City	Jos. A. Lockwood.
Springfield, O.	31,895	38,000	..	3.000	70	Yes	8	4	105	3.5	92	3	79	Yes	Yes	All	Yes	Yes	City	W. R. Smith.
Quincy, Ill.	31,494	36,000	60	1,572	575	Yes	9	2.5	174	5	347	0.75	53	No	Large	....	Yes	....	Co.	Dorr R. Gwinn.
Mobile, Ala.	31,076	31,000	36	1,800	20	Yes	12	4	202	3	152	3.6	182	Yes	Yes	Large	Yes	No	Co.	A. W. McCallum.
Altoona, Pa.	30,357	40,000	1	7,000	30	No	..	....	...	....	...	2	50	Yes	Yes	Large	Yes	No	City	S. A. Gailey.
Terre Haute, Ind.	30,217	30,217	..	1,874	92	Yes	3	....	...	....	...	3	99	Yes	Yes	Large	....	Yes	Co.	L. L. Williams.
Elmira, N. Y.	29,709	35,000	30	3,000	304	No	8	3	123	3	123	2.5	102	Yes	Yes	All	Yes	No	Co.	J. M. Diven.
Bay City, Mich.	27,859	33,000	60	1,717	393	Yes	10	3.5	265	3.3	250	2.6	200	No	Yes	All	Yes	No	City	E. L. Dunbar.
Akron, O.	27,601	35,000	65	2,270	125	Yes	5	2.8	228	2.5	204	.....	...	No	Yes	Large	Yes	No	Co.	H. C. Starr.
Davenport, Ia.	26,872	35,000	..	2,500	400	Yes	10	5	143	3.5	100	2.5	71	No	Yes	All	Yes	No	Co.	T. N. Hooper.
Pawtucket, R. I.	.....	60,000	8	5,990	4,080	Yes	12	...	...	...	...	4.3	78	....	Yes	Yes	Yes	No	City	Edwin Darling.
Canton, O.	26,189	32,000	50	3,200	26	Yes	5	3.5	219	2.3	143	2	125	Yes	....	Yes	Yes	....	City	L. B. Ohliger.
Birmingham, Ala.	26,178	50,000	20	4,000	400	Yes	20	6.5	162	6.5	162	6	150	Yes	Yes	Large	Yes	Yes	Co.	W. J. Milner.
Taunton, Mass.	25,448	25,448	14	3 507	1,036	Yes	3	2	91	12.5	57	1	46	Yes	Yes	Large	Yes	....	City	Geo. F. Chace.
Joliet, Ill.	23,264	30,000	80	1,200	25	Yes	7	2.5	416	2.4	400	.....	...	Yes	Yes	All	Yes	Yes	City	Frank Demcy.
Oshkosh, Wis.	22,836	25,000	75	1,506	35	Yes	10	3	470	2.5	392	2	320	Yes	Large	.....	No	..	Co.	W. G. Maxcy.
Macon, Ga.	22,746	32,000	66	2,100	268	Yes	5	2.7	253	2.3	216	1.7	161	Yes	Yes	All	Yes	Yes	Co.	A. E. Boardman.
Muskegon, Mich.	22,702	25,000	50	1,700	.....	Yes	8	3.1	249	2	158	2.3	186	Yes	Large	Large	Yes	No	City	Wm. Dixon.
Burlington, Ia.	22,565	2 ,500	..	1,850	80	Yes	12	3	135	1.8	82	1.7	77	....	Yes	.....	Yes	No	Co.	Chas. Hood.
Montgomery, Ala.	21,883	30,000	..	2,400	800	Yes	8	1.6	53	1.3	43	1.1	36	Yes†	Yes	All	Yes	....	Co.	.....
Oswego, N. Y.	21,812	26,400	..	1,294	112	Yes	5	2.1	79	2.2	84	2.1	82	Yes	Large	.....	Yes	No	Co.	F. H. Bennett.
Johnstown, Pa.	21,805	33,000	15	4,700	.....	No	..	....	...	...	...	.....	...	Yes	Yes	.....	....	...	Co.	A. H. Walters.
Meriden, Conn.	21,652	28,000	20	3,300	120	No	5	...	...	....	...	2	88	Yes	Large	Large	....	Yes	City	H. L. Schleiter.
Lexington, Ky.	21,567	25,000	..	1,180	972	Yes	3	1.5	60	0.75	30	0.75	35	No	Yes	All	Yes	No	Co.	S. A. Charles.
Zanesville, O.	21,009	21,500	1	4,209	30	Yes	10	2.8	133	2.8	133	2.8	133	No	Yes	Yes	Yes	Yes	City	R. N. Saup.
Woonsocket, R. I.	20,830	24,525	7	1,467	1,274	Yes	5	0.8	40	0.75	29	0.5	20	No	Yes	All	Yes	No	City	Byron W. Cook.
York, Pa.	20,793	23,000	..	5,800	15	No	3	2	87	1.6	70	1	..	Yes	Yes	Large	Yes	No	Co.	Jacob N. Kuhn.
McKeesport, Pa.	20,744	25,000	10	3,000	400	Yes	11	3.5	155	3.6	160	3	133	Yes	Yes	Yes	Yes	Yes	City	Jos. R. Ecoff.
Chester, Pa.	20,226	.....	..	4,500	200	..	..	....	...	....	...	2	98	Yes	....	.....	Yes	....	Co.	W. B Chadwick.
Schnectady, N. Y.	19,902	22.000	50	1,100	5	Yes	10	4.5	409	4	364	4.2	386	Yes	Yes	All	Yes	Yes	City	Geo. T. Ingersoll.
Norristown, Pa.	19,791	23,000	10	.....	.....	Yes	7	2.5	120	1.7	84	1.8	90	Yes	Yes	Large	Yes	No	Co.	Jno. Slingluff.
Nashua, N. H.	19,311	22,000	5	3,000	160	Yes	16	3	146	3.2	155	2.8	135	Yes	Yes	.. ..	Yes	....	Co.	H. G. Holden.
Waltham, Mass.	18,707	22,000	10	3,000	60	Yes	3	1.7	86	1.2	63	0.9	47	Yes	Large	.....	Yes	No	City	Geo. E. Winslow.
Elgin, Ill.	17,761	23,000	55	1,968	92	Yes	3	1.5	145	0.5	48	0.7	68	No	Yes	All	Yes	No	City	R. R. Parkin.
Hamilton, O.	17,415	21,000	50	2,206	275	Yes	3	1.6	152	1	95	1	100	No	Yes	**	....	Yes	City	Jno. Fisher.
Eau Claire, Wis.	17,366	19,000	70	1,350	20	Yes	8	2.7	483	1.3	241	1.7	298	No	Yes	All	Yes	No	Co.	W. H. Willard.
Pittsfield, Mass.	17,281	17,500	50	3,500	35	No	..	....	...	..	...	.....	165	Yes	Yes	Large	Yes	No	City	J. M. Hatch.
Concord, N. H.	17,004	18,000	16	2,800	43	No	2	0.5	26	....	...	.....	...	Yes	Yes	Yes	Yes	....	City	V. C. Hastings
La Fayette, Ind.	16,243	18,000	..	1,805	21	Yes	3	2.9	161	2.9	161	1.9	107	..	Large	Yes	Yes	....	City	Ed. Cunningham.
Roanoke, Va.	16,159	23,600	26	3,018	250	Yes	3	2.7	157	2.4	139	2.5	145	Yes	Yes	Large	Yes	No	Co.	J. C. Rawm.
Norwich, Conn.	16,156	24.000	4	4,000	85	....	..	....	...	....	...	0.8	35	Yes	Yes	All	Yes	....	City	C. S. Bartlett.
Lima, O.	15,987	20,000	55	1,806	52	....	6	1 3	149	0 8	91	0.75	84	No	Yes	Yes	Yes	No	City	D. E. Fritz.
Stamford, Conn.	15,709	17.0 0	..	1,736	15	....	..	....	...	....	...	1.5	88	Y-s	Yes	Yes	Yes	...	Co.	G. K. Whitney.
Columbia, S. C.	15,353	18,000	20	.....	.....	Yes	5	1.4	97	1 3	90	1.3	94	Yes	Yes	All	Yes	No	City	J. A. Fetner.
Galesburg, Ill.	15,264	20,000	80	650	108	Yes	1	0.6	145	0.6	127	.....	...	No	Yes	All	Yes	Yes	City	J. C. Stevens.
Evanston, Ill.	11,052	18,000	..	2,400	.....	Yes	7	5.3	292	3	167	2.6	146	....	....	.....	....	....	.....	.....

* The amount pumped per day per person is based on the total population using water from water-works. † Favors inspection without meters. ‡ The question in the original table was: "Would you put meters on all water takers or only the large consumers, and where house inspection showed that fixtures were leaking?" It is obvious that yes or no to such a question is not a definite answer, but where "large" or "all" is the reply there can be no doubt as to the meaning. § It will be noticed that yes is sometimes answered to each of these questions. ** All or none.

saving on your coal bills alone will more than pay the interest (on the cost of meters).

The city will have to keep the meters in order, and should, therefore, own and select them. If owned by a consumer there is no inducement (to him) to repair them if they stop. We require the consumer to pay in advance for as much water as equals the cost of the meter, to be used by him faster or slower, as he pleases, but at a minimum price of 50 cts. per month. We think that in a number of devices for facilitating work on the meter system we lead many larger cities.

Zanesville, O., R. M. Saup, Superintendent: Meters should be put in where there are sewer connections.

Woonsocket, R. I., Byron I. Cook, Superintendent: Meters are put on all services that have more than two faucets; these must be self-closing. Any hose connections must have meters. Our consumption in 1892 was 17.28 gallons per capita.

McKeesport, Pa., Jas. Ecoff, ex-Superintendent: The money invested in water meters will practically double the capacity of the works, give a full and legitimate supply to all consumers and effect a great saving in cost of plant and operation.

Chester, Pa., W. B. Chadwick, Superintendent: In

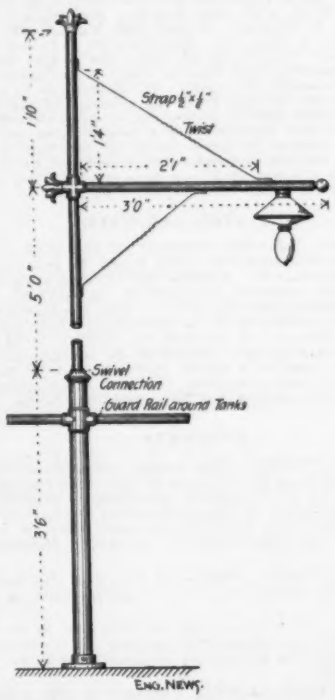

Fig. 96. Electric Lamp Standard.

1889, with 3,200 odd customers and no meter, this plant was pumping 3,800,000 gallons. In 1893, with 4,500 odd customers and 200 meters on manufacturers, livery stables, hotels and laundries, we were pumping 2,000,000 gallons daily. House to house inspection goes on every year.

Elgin, Ill., R. R. Parkins, Superintendent: We expended $6,000 in the extension of our filter plant. If we had bought meters instead we should not have had to buy additional filters for six years, and would have increased our revenue 20%. If you own the meter you can adopt a good one, and when out of repair you can have it put in order. If consumer owns it he can be made to repair it only when he gets ready.

Hamilton, O., John Fisher, Secretary: I would meter all or none. We find that parties whose water is metered go to their neighbors' hydrant which is not metered, and use water from same. If I could do no better I would meter only large consumers.

Eau Claire, Wis., W. H. Willard, Secretary: Would meter all takers except small houses not connected to sewer.

The time will come, with unrestricted waste, when a pressure cannot be maintained over the whole pipe line, on account of increased friction. I calculate that a judicious use of meters will bring down our daily use of water at least one-half and not decrease the revenue at all.

Roanoke, Va., J. C. Rawn, Manager and Engineer: We have adopted the meter for universal use and are expecting to have every service metered within ten years. We have placed nearly 200 meters since June 1 and to Sept. 1. The saving in water pumped amounted to 57,000,000 gallons and our average revenue per 1,000 gallons, which last year amounted to 4.7 cts., has been raised to 7.2 cts.

Lima, O., D. E. Fritz, Superintendent: I cannot see any comparison between cost and maintenance of meters and pumping machinery. You cannot prevent waste of water save by making persons pay for what they take, then waste will cease.

In addition to what is given above one official states that he favors an inspector provided the

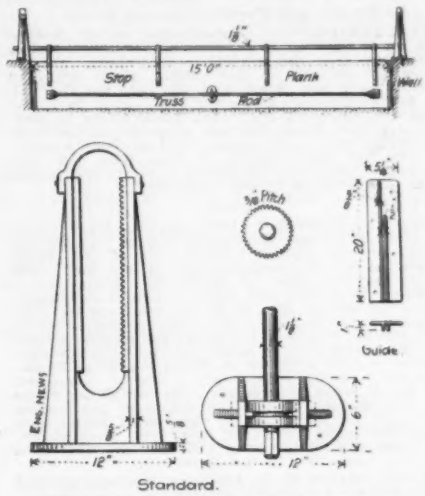

Fig. 97. Stop Plank and Lifting Device.

latter boards in the house he is inspecting, and another favors inspectors when armed with police powers.

Further results of Mr. Maddock's investigations will be given in another issue.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago—Existing Roads.

BUFFALO & SUSQUEHANNA.—It is stated that the contract will probably be awarded this month for the proposed extension from Galeton east to Ansonia, Pa., a distance of 18 miles. The work will include several 60 to 100-ft. bridges. Gen. Man., C. W. Goodyear, Buffalo, N. Y.

DRUMMOND COUNTY.—The survey and location of the extension of this railway from St. Leonard to Chaudiere, Que., has been completed, according to press reports. The construction is expected to be commenced early in the spring. The new extension is 45 miles in length, the first 25 of which passes through a dense forest country. The bridging of the streams will not be a serious matter.

KINGFIELD & DEAD RIVER.—About eight miles of track remains to be laid on this road from Kingfield north to Treadwell, Me. Some 1½ miles have been laid this fall, and the road, which is all graded, will be completed in the spring.

LAKE ERIE & WESTERN.—A mortgage was filed in the Delaware county Recorder's office at Muncie, Ind., Jan. 10, to secure a loan of $1,000,000 for the Manhattan Trust Co. in favor of the Indianapolis, Anderson and Muncie division of the Indianapolis & Northeastern Ry. Co., of which W. E. Hackedorn, of that company, is secretary. It is reported that this means a more direct line from Muncie to Indianapolis for the L. E. & W., which is anxious to touch Anderson to compete with the Big Four. The line will cover 90 miles of territory in Indiana.

PHILADELPHIA & READING.—The mayor of Philadelphia has reported to the councils the plans agreed upon between the municipal authorities and the receivers of this company for the removal of the grade crossings on Pennsylvania Ave. in that city. The agreement provides, according to reports, for an open subway from Broad St. to Twenty-first St., and for a tunnel west of that point to the open cut and subway system south of Girard Ave. The cost will be between $5,500,000 and $6,000,000, to be borne equally by the company and the city. The mayor has also sent a special message to councils recommending a loan for this improvement. It would do away with 20 dangerous grade crossings and would prove of much benefit also to the Baltimore & Ohio.——The citizens of Hazleton, Pa., are trying to secure an extension to that city, according to reports.——It is reported likely that construction will soon be resumed on the Frankford branch, three miles long. The work was commenced last year and includes some heavy work.

ST. MARY'S & SOUTHWESTERN.—This railway is now completed from St. Mary's to Centerville, in Elk county, Pa., 10 miles, and will probably be extended at once about a mile to connect with the Daguscahonda road. Gen. Man., Andrew Kaul, St. Mary's, Pa.

Projects and Surveys.

BENTON HARBOR & SOUTHEASTERN.—A press report from Benton Harbor, Mich., states as follows: It is now positively stated that the spur of a proposed continental railway, Dailin's road, from Napanee, Ind., to Benton Harbor, will be built in 1894 and that work will be commenced upon it by Feb. 1. London capitalists who were at first backing the scheme declined to go ahead on account of the hard times, but now sufficient American capital has been enlisted to construct the road. The line will be a first-class standard gage. About five miles of grading is already completed. The road will be extended to Bluffton, Ind., connecting there with a line to Cincinnati.

CLEVELAND & SOUTHWESTERN.—D. R. Cook, Hastings, Mich., and Maj. G. M. Anderson, Detroit, have secured over half of the right of way for this proposed road from Cleveland to Medina, according to reports. The road would give the Cleveland, Lorain & Wheeling a direct entrance into Cleveland.

COAST RY. OF NOVA SCOTIA.—This road, referred to recently as the Nova Scotia Coast Line, will extend from Yarmouth, where it will connect with the Yarmouth & Annapolis road and also the steamship line from Boston to Lockeport, a total length of 91 miles. The preliminary survey has been made over the entire line and the first 10 miles to Tusket has been located. The work will be light, and it is proposed to begin the construction in the spring. The gage will be 2 ft. The freight to be carried will be mostly fresh fish, lumber and general merchandise, which is now carried by wagon or in small sailboats. The general contractor is A. H. Chadbourne, 29 Broadway, New York city.

Southern—Existing Roads.

CARRABELLE, TALLAHASSEE & GEORGIA.—It is reported that this road will be extended from Tallahassee north to Thomasville, Ga., this year. The line has been located. Ch. Engr., Frank P. Damon, Tallahassee, Fla.

CARTHAGE & WESTERN.—This railway has been completed from Carthage to Currersville, N. C., 11 miles, and will probably be operated by the Seaboard Air Line, with which it connects at Carthage.

JACKSONVILLE, ST. AUGUSTINE & INDIAN RIVER.—The railway is now open for traffic from St. Augustine south to Fort Pierce, Fla., 200 miles, and from West Palm Beach, near Lake Worth, north to Jupiter, 18 miles, leaving a gap of about 40 miles yet to be completed. Steamers now ply between Fort Pierce and Jupiter. Ch. Engr., Chas. O. Haines, Sebastian, Fla.

MACON, DUBLIN & SAVANNAH.—It is reported that this railway will be extended this year from Dublin to Savannah, Ga., 117 miles. Act. Supt., D. B. Dunn, Macon, Ga.

SUMTER, LAKE CITY & CONWAY.—Press reports state that the grading of this proposed railway has been commenced. Pres., Henry W. Mackey, Sumter, S. C.

TAMPA & THONOTOSASSA.—The construction of this railway was commenced Nov. 26 and completed Dec. 29. It is 14 miles long, standard gage and cost $8,000 per mile. Pres., S. A. Jones, Tampa, Fla.

Projects and Surveys.

BROWNSTONE & COAL RIVER.—It is reported that rails and ties have been purchased for building five miles of this railway. The projected line is from Brownstone to Madison, W. Va., 20 miles. Pres., Geo. Davis, Charleston, W. Va.

CHATTANOOGA WESTERN.—Contracts will soon be awarded for building 22 miles of this railway, according to reports. The work includes a steel bridge over the Tennessee River. Pres., T. J. Nicholl, Chattanooga, Tenn.

ELKTON & SOUTHERN.—The report of the preliminary survey for this proposed railway from Childs Station on the Baltimore & Ohio south to the Baltimore & Delaware Bay road, about 25 miles, is being considered. The company has been incorporated by Geo. Biddle, Dr. Howard Bratton, Elkton, Md., and others; capital stock, $110,000.

FAIRMOUNT VALLEY.—This company is reported as preparing to build a railway from Cartersville, Ga., to Middlesboro, Ky., by way of Cleveland and Kingston, Tenn. Messrs. Aubury and Smith, Cartersville, Ga., are interested.

FLORIDA.—O. M. Crosby, Avon Park, Fla., is reported as interested in a proposed railway from Avon Park to Haines City.

GEORGIA.—It is stated that J. M. Woods, Statesboro, Ga., will soon construct a private railway from his turpentine plant to a connection with the Savannah, Americus & Montgomery.

KENTUCKY.—Reports state that Wolf & King, Duluth, Minn., are about ready to award subcontracts for the 60 miles of railway to coalfields in Eastern Kentucky referred to Dec. 28.

Northwest—Existing Roads.

BOONE VALLEY COAL & RY.—An extension from Fraser to Boone, Ia., is reported as under consideration. Pres., Hamilton Browne, Fraser (P. O., Pilot Mound), Ia.

CHICAGO, MILWAUKEE & ST. PAUL.—Plans have been prepared for lowering the tracks of this railway in Minneapolis; estimated cost, $2,000,000 to $3,000,000.

CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA.—Press reports state that this company is considering an extension of its Sioux City and Ponca line from Newcastle, Neb., through Niabrara to Butte City, a new town in Nebraska on the recently opened Sioux reservation, a distance of 100 miles.

DULUTH, PIERRE & BLACK HILLS.—Press reports from Aberdeen, S. Dak., state that contests over the right of way for this railway to Pierre, 130 miles, have been settled and that negotiations are being made for completing the road. The contract for building this was awarded a year ago and the line nearly all graded. Jas. A. Ward is general manager.

RICE LAKE, DALLAS & MENOMINEE.—It is proposed to extend this railway from Cameron to Dallas, Wis., 12 miles. The road has been completed from Rice Lake to Cameron, seven miles. Ch. Engr., H. E. Clark, St. Paul.

YANKTON, NORFOLK & SOUTHWESTERN.—It is expected that this railway will be completed this year from Yankton, S. Dak., to Norfolk, Neb., 65 miles. The grading and bridging was done some time ago by the Traffic Const. Co., of Yankton, S. Dak., but no track has yet been laid.

Projects and Surveys.

CHICAGO, PADUCAH & MEMPHIS.—It is reported that the contract for building this railway from Altamount to Marion, Ill., about 95 miles, will probably be awarded this month to Johnston Bros. & Faught, St. Elmo, Ill. The incorporation of the company was noted Jan. 4 and it is stated to be in the interest of the Paducah, Tennessee & Alabama.

DULUTH & CARRINGTON.—The Duluth "Herald" states that R. S. Munger of that city is the projector of a railway to run from Duluth, Minn., west to Carrington, N. Dak., striking the Red River Valley north of Fargo and south of Caledonia. The farmers of several of the prairie counties through which the line will run have offered to grade it free of charge and a valuable donation of land is already pledged to the projectors. It is estimated by J. J. Durage, Engr., after a careful investigation, that the roadbed could be graded at a cost of about $1,500 per mile, exclusive of

bridgework and rockwork at the Duluth end. Mr. Munger will lay the matter before the Canadian Pacific directors, who are said to be alive to the value and feasibility of the road.

ILLINOIS.—Press reports state that J. B. and C. W. Cuykendall, Chicago, are the projectors of a proposed railway from a connection with the Chicago & Northeastern either at Barrington or Palatine, Ill., by way of Lake Zurich, Wauconda, Volo, Fox Lake and Richmond to Lake Geneva, Wis. Meetings have been held at Wauconda, Lake Zurich, Volo, and the property owners along the proposed route have promised to give liberally both in land and money. At Wauconda $10,000 has been raised.

INDIANA & NORTHERN.—Surveys are being made for this belt railway to connect Blue Island, Ill., with Hammond, Ind. The line would be nine miles in length and form a connection between the Michigan Central, the Louisville, New Albany & Chicago, the Chicago & Erie, the Panhandle, the Chicago, Rock Island & Pacific, and the Wabash roads. It is said to be the intention to push construction as rapidly as possible. The promoters of the enterprise are the managers of the George H. Hammond Packing Co., the object being to secure a more direct way of getting live stock and dressed beef shipments from the Rock Island tracks at Blue Island to the company's packing house at Hammond. When completed it is understood that the line will be operated by the Michigan Central. Pres., J. P. Lyman; Gen. Man., K. H. Bell.; Treas., J. A. Ostrom.

METROPOLITAN UNION DEPOT & RY.—Incorporated at Omaha, Neb., to secure new terminal facilities in that city, including a union station; estimated cost, $1,750,000; capital stock, $500,000; Guy C. Barton, H. W. Yates, Herman Kountze, B. F. Smith, C. W. Hamilton, Frank Murphy and others.

Southwest—Existing Roads.

GREENFIELD & NORTHERN.—It is reported that an extension is under consideration from Greenfield to Stockton, Mo. Gen. Man., T. A. Miller, Aurora, Mo.

GULF, BEAUMONT & KANSAS CITY.—Press reports state that contracts have been awarded for a 10-mile extension, including 1½ miles of trestles and bridges. Mr. Hanson will build the trestles, and Snyder Bros. will do the grading, both firms being residents of Houston, Tex. The work is to be completed by May 1.

MISSOURI SOUTHEASTERN.—Reports state that it is hoped to build the extension from Zeta to Morley, Mo., 14 miles, this year. Gen. Man., Geo. H. Crumb, Bloomfield, Mo.

SHERMAN, SHREVEPORT & SOUTHERN.—The officials of this railway are investigating the proposed route from Jefferson, Tex., to Shreveport, La.

SOUTHWEST, ARKANSAS & INDIAN TERRITORY.—It is reported that this company expects to build a 10-mile extension this year. Ch. Engr., N. S. Woods, Arkadelphia, Ark.

TEXARKANA & FORT SMITH.—This company has offered to build an extension from Texarkana, Tex., south to the Sulphur River, eight miles, if that city will loan the company $30,000. It is reported probable that the proposition will be accepted.

TEXAS CITY TERMINAL.—An exchange states that this road was built in 1893 from Texas City Junction to Texas City, Tex., five miles, and that it is proposed to extend the line from Texas City Junction to the Gulf, Colorado & Santa Fe, two miles, and from Texas City to Houston. Gen. Man., J. R. Myers, Galveston, Tex.

TEXAS, SABINE VALLEY & NORTHWESTERN.—A 20-mile extension is proposed to connect with the Houston, East & West Texas. Gen. Man., Richard J. Evans, Longview, Tex.

TEXAS TRUNK.—Press reports from Athens, Tex., state that the citizens are negotiating for an extension of this railway to that city, the present terminus being 22 miles north of there.

Projects and Surveys.

DAKOTA, WICHITA & GULF.—At a meeting of the directors held at Wichita, Kan., Jan. 10, it was voted to build the first section of the road, from Wichita, Kan., to Denison, Tex., there now being sufficient funds assured to complete that much of the line, according to reports. It is stated that the plans contemplate absorbing some of the north and south feeders of the Santa Fe system, and that the contract for grading the remaining part of the road is about ready to be signed.

KANSAS CITY, OKLAHOMA & SOUTHWESTERN.—Reports state that work will be commenced at once on this road from Caney, Kan., to Guthrie, Okla., and thence southwest to Vernon, Tex. Robert Martin, Pres., Guthrie, is said to have made arrangements with Northern capitalists to furnish the money.

LOUISIANA.—A report from Franklinton, La., states as follows: The police jury of this (Washington) parish has passed a resolution exempting from parish taxation for a period of five years any railway company or corporation that would build a road to this town. This, taken in connection with the railway mass meeting to be held here Jan. 27, goes to show that the people are determined to have a railway.

NEVADA & EL DORADO.—Press reports state that it is hoped to build this projected road this year. Fremont Wilson surveyed the line, between Nevada and El Dorado, Mo., 23 miles, last fall and submitted a proposition to the citizens of Nevada, Mo., for constructing the road.

OKLAHOMA CENTRAL.—O. G. Jones, Pres., Oklahoma City, Okla., is reported as stating that contracts will probably be awarded within 90 days for building the first section of this road from Sapulpa to Oklahoma City, 95 miles. The line will have few curves and will require very little grading. The line is projected to El Paso, Tex., 300 miles.

PALESTINE & DALLAS.—Burkitt & Murphy, Palestine, Tex., have been examining the proposed route for this road, which they expect to build this year. The distance between the two cities is 100 miles by air line, but the road will probably be considerably longer than this. The road will ultimately connect with the Southern Pacific at Beaumont, the Texas Trunk being used as a link.

SAN ANTONIO & GULF SHORE.—The incorporation of this company to build a railway from San Antonio to Velasco, Tex., 200 miles, was noted in our issue of Jan. 4. The counties along the line have voted about $300,000 as subsidy for the proposed road, and the directors have authorized a first mortgage bond issue of $12,000 per mile. Contracts are now being made, according to reports, for building the first 75 miles. Pres., Wm. Davis, San Antonio, Tex.

Rocky Mt. and Pacific—Existing Roads.

CANADIAN PACIFIC.—Construction on the Nakusp & Slocan is reported as progressing favorably, and it is expected that the grading and bridging will be finished by the end of this month. There are nine miles of track now down, and the rails for the balance are at Revelstock, on the main line. It is expected that the track will reach Three Forks in May. There are now about 400 men at work on the road, there having been about as many laid off about a month ago. The line will be about 30 miles long, and it is built to give the Canadian Pacific a line to the mining district in Southern British Columbia.

Foreign.

MEXICAN WESTERN.—Press reports from Guaymas, Mex., state that the construction of this railway is being actively pushed, a large force of men being at work on the Topolobampo end of the line. This road is the enterprise of Albert K. Owen, No. 1 Broadway, New York, the leader of the Topolobampo co-operative colony. The road will run from the Port of Topolobampo, on the Pacific coast, to Eagle Pass or to Presidio del Norte, on the Upper Rio Grande border, where a crossing will be made into the United States, and thus connect with the Southern Pacific in Texas. The road is being built under a liberal concession from the Mexican government. The terminus of the road, Topolobampo Bay, is claimed to be the nearest Pacific port for all places in the United States east of the Mississippi River, it being 340 miles nearer New York, 195 miles nearer Chicago, and 316 miles nearer St. Louis than is San Francisco.

MEXICO.—Rafael M. de Arozorena has been granted a concession for a railway from Pachuca to San Miguel, through a rich mining district. It is said that the road will be built this year.

STREET AND ELECTRIC RAILWAYS.

GARDNER, MASS.—The Gardner Electric St. Ry. Co. has petitioned for a franchise for a road 3½ miles long. The stock has all been subscribed for and temporary directors elected, including L. A. Greenwood and J. A. Styles.

MARLBORO, MASS.—The State Central St. Ry. Co. has been granted a franchise in this city.

WHITE PLAINS, N. Y.—It is stated that 90% of the property owners have signed a petition in favor of the proposed electric railway.

BRIDGETON, N. J.—A press report states that the citizens of Fairfield and Lawrence townships have voted by large majorities in favor of allowing the tracks of the Bridgeton, Cedarville & Port Norris Ry., a proposed trolley road, to run through those townships and through the villages of Fairton and Cedarville. The meetings were held as a guide to the township committee.

NEWARK, N. J.—The Essex county road board has granted the Suburban Traction Co. permission to lay a double track on Central Ave. from Lincoln Ave. to South Jefferson St., in this city, and also for an extension of its present line from the D., L. & W. R. R. to South Jefferson St. The company will make this extension a trolley road.

KITTANNING, PA.—C. A. Siegfried, New York, is reported to have secured for a New York company the charter granted two years ago to J. C. Jessup, Fred Wick and others for an electric railway from this city to Ford City, with extensions to Wick City and Nealton. The road is expected to be in operation this next summer.

READING, PA.—Stock has been subscribed for the proposed extension of the Reading & Southwestern Electric Ry. to Adamstown. Pres., Ludwig T. Custer; Treas., Geo. W. Keim.

CHARLOTTESVILLE, VA.—The Piedmont Construction Co. has been granted a franchise for an electric railway in this city, the construction to be commenced within 90 days.

PETERSBURG, VA.—A bill has been introduced in the state senate for the incorporation of the Virginia Electric Ry. Co. by R. A. Patterson, A. W. Garber, G. B. McAdams, B. B. Munford and others, to construct railways in this city, Richmond, Norfolk and elsewhere; capital stock, $500,000.

BENWOOD, W. VA.—C. C. Smith has commenced the surveys for the proposed electric railway to Moundsville, 12 miles, noted Dec. 21.

AUGUSTA, GA.—The North Augusta Land Co. is reported as about to construct an electric railway from the city to its property in the suburbs.

OPELIKA, ALA.—The Auburn & Opelika St. R. R. Co. has been formed to build an electric railway to Auburn, a distance of seven miles. It is estimated the road will cost $60,000. Ch. Engr., John T. Cowan.

LOOKOUT MOUNTAIN, TENN.—M. H. Henderson is reported as interested in the proposed inclined cable railway to the top of Lookout Mountain. The $75,000 required is said to have been secured.

BEREA, O.—A dispatch to the Cleveland "Leader" states as follows: The Cleveland & Berea St. Ry. is to be at once equipped with the trolley system and a full equipment of rolling stock. So far the storage battery system has not given the best of satisfaction. Numerous breakdowns have caused the trips to be very irregular. With good motors and hourly trips between here and Cleveland, it is expected that the traffic will be larger.

NORWALK, O.—The directors of the Sandusky, Milan & Norwalk Electric Ry. have ordered the material for the extension on West Main St., this city, and the construction will be hastened as soon as favorable weather comes. The work will cost about $13,000.—The directors of the Norwalk, Fairfield & Southern R. R. Co. have petitioned the council to submit to the citizens a proposition to issue bonds for $35,000 to aid in the construction of an electric railway from this city by way of Fairfield to some point on the Big Four, the P., A. & W., or the B. & O. The people are reported as in favor of the proposition.

BENTON HARBOR, MICH.—A press report states that C. P. Wright, Pres. and projector of the Lake Shore Electric Ry., is securing right of way for his line from St. Joseph to Stevensville, and that he proposes to have the line in operation by June 15, to connect with the proposed road from South Bend.

CHICAGO, ILL.—The Chicago Suburban Rapid Transit Co. has been incorporated by C. H. Jackson, L. E. Sauter, A. D. Baldwin (attorneys at 84 La Salle St.) and others, to construct a railway from this city to the towns of Wayne and Winfield, Du Page county, and to Maine, Cook county; capital stock, $500,000.

OSHKOSH, WIS.—It is reported that Indianapolis capitalists offer to construct an electric railway in this city if the franchise of the company now running horse cars here can be purchased on reasonable terms.

FORT SMITH, ARK.—The Fort Smith & Van Buren R. R. Co. has been incorporated by M. N. Beaty, Lima, O.; J. L. Rea, Van Buren, Ark.; G. H. Walsh, this city, and others, to build a railway between the cities named, a distance of four miles.

OAKLAND, CAL.—The Oakland R. R. Co. has been incorporated by Chas. F. Crocker, H. E. Huntington, S. T. Gage, C. E. Green and F. S. Douty (all reported as connected with the Southern Pacific) to construct 12⅞ miles of street railways in this city, Berkeley and other parts of Alameda county; capital stock, $2,500,000.

SAN FRANCISCO, CAL.—George J. Buckland has petitioned for a street railway franchise from Golden Gate Park at Fell and Stanyan Sts. along many streets to a terminus at East and Market. He proposes to lay a single line, with turn-out switches three blocks apart. Electricity is to be the motive power, but he especially says that he will not use the trolley system, according to reports. He guarantees to spend $50,000 within 60 days from the granting of the franchise, to spend $200,00 in 90 days, to spend $500,000 for tracklaying and machinery in 6 months, and to complete the system in three years. In addition to the 2% which the city demands upon franchises, he promises to pay a bonus of 5% on each week's gross earnings in consideration of a 50-year franchise.

ELEVATED RAILWAYS.

CHICAGO, ILL.—The residents of the town of Cicero have petitioned the town board to pass an ordinance immediately granting the necessary right of way for the proposed extension of the Lake St. Elevated R. R. through the town.—The stockholders of the Lake St. Elevated R. R. have unanimously authorized the directors to proceed at once to build and equip the branch lines authorized by the council last year. The president's report shows that 18,600 lin. ft. of road has been completed and that the material is on hand and ordered for the completion to the city limits.

HIGHWAYS.

MASSACHUSETTS.—The county commissioners will build a road from the terminus of Pawtucketville boulevard, Lowell, to Tyngsboro, according to reports.—The commissioners of Hampden county have petitioned the state board of highways to allow them to build a highway from Springfield to Russell, a distance of 24 miles.

PENNSYLVANIA.—Willistown township will borrow $40,000 with which to pave the main roads in the township.

KANSAS.—An election will be held Jan. 27 in Lee and Waldron townships, Platte county, to decide upon the question of a main road to Leavenworth, to cost about $10,000.

TEXAS.—Plans are being discussed by the commissioner of Harris county for the building of four roads each four miles in length, to the county seat.

BRIDGES AND TUNNELS.

NEW BEDFORD, MASS.—Concerning the item published last week, which was taken from a late newspaper clipping, J. D. Fouquet, New York, writes us as follows: Early in November last I was employed as consulting engineer to investigate and report on the elimination of grade crossings of the Old Colony R. R. through the city of New Bedford, Mass. A plan for a bridge with draw span and estimate of cost had been submitted by a Mr. Shaw, of Boston. This bridge spans the Acushnet River and is to take the place of the present structure. The approach crossing to the bridge was the only matter considered in connection with the abolition of grade crossings, and I really had nothing to do in the matter of the bridge itself.

ALBANY, N. Y.—The following bids were received Jan. 11 by Edward Hannan, Supt. Pub. Wks.: For rebuilding bridge over the Erie Canal at Ann St., Little Falls.—Groton Bridge & Mfg. Co., Groton, $3,574; Hilt & Johnson, Albany, $4,789; Kellogg Iron Wks., Buffalo, $2,732 (awarded contract); Hilton Bridge Const. Co., Albany, $3,392. Rebuilding bridge, wrought iron superstructure, over Erie Canal at Ford St., Rochester,—Berlin Iron Bridge Co., East Berlin, Conn., $3,602; Rochester Bridge & Iron Wks., Rochester, $3,914; Wrought Iron Bridge Co., Canton, O., $3,875; Elmira Bridge Co., Elmira, $3,660; Groton Bridge & Mfg. Co., $4,025; O. W. Martin, Havana, $3,726; Hilt & Johnson, $4,675; Kellogg Iron Wks., $2,845 (awarded contract); Hilton Bridge Const. Co., $4,000. Rebuilding bridge over Erie Canal at Bridge St., Amsterdam,—Groton Bridge & Mfg. Co., $3,345; Hilt & Johnson, $4,562; Kellogg Iron Wks., $2,363 (awarded contract); Hilton Bridge Const. Co., $3,187. Constructing lift bridge over Erie Canal at Clinton St., Syracuse,—Substructure; Mara & Nesdall, Syracuse, $4,540; Edward S. Candee, Syracuse, $5,153; Hughes Bros., Syracuse, $4,488; Brammelkamp & Lane, Syracuse, $4,875; Pidgeon & Co., Albany, $4,234 (awarded contract); Superstructure; Hilton Bridge Const. Co., $7,280; Hilt & Johnson, $8,768; Groton Bridge & Mfg. Co., $8,035; Wrought Iron Bridge Co., $7,000 (awarded contract).

NIAGARA FALLS, N. Y.—A bill has been introduced in the state assembly authorizing the Niagara Falls Suspension Bridge Co., composed of Oswego and Buffalo capitalists, to construct a new suspension or

arch bridge across the gorge of the Niagara River below the falls. The bill provides for the running of electric, cable or horse cars across and prohibits locomotives or trains. It permits the company to increase the capital stock to $350,000 and prohibits the charging of excessive tolls. The power to lease is also granted the company. A similar bill will be introduced in the Canadian parliament.

WEST NORFOLK, VA.—A bill has been introduced in the state legislature to incorporate the West Norfolk & Port Norfolk Drawbridge Co., which proposes to build a drawbridge over the Elizabeth River between this city and Port Norfolk; capital stock, $25,000; R. E. B. Stewart, W. L. Wise, M. W. Dennis, of Norfolk county, and others.

CINCINNATI, O.—The contract for a bridge across the Miami River at Miamitown has been awarded by the county commissioners to the King Bridge Co., at $41,400, the other bids being as follows: Bracket Bridge Co., $41,600; Wrought Iron Bridge Co., $43,9 ; Edge Moor Bridge Wks., $24,433; Detroit Bridge Co., $39,000; Massillon Bridge Co., $34,500; Bradbury & Spencer, $29,400.

COLUMBUS, O.—Bids are asked until Feb. 9 for an eight span plate girder bridge over the railway tracks at St. Clair Ave., Marion township. Henry J. Carens, Co. Aud.

VERMILLION, O.—About five sections of the bridge carrying the New York, Chicago & St. Louis Ry. across the river at this place were burned Jan. 11.

LOS ANGELES, CAL.—The council is considering revised plans for the proposed Third St. tunnel; estimated cost, $100,000 to $150,000.

WINNIPEG, MAN.—The legislature will be petitioned for authority to issue bonds for the following bridges, according to reports: Over the Assiniboine River, at Main and Osborne Sts., $80,000; over the Canadian Pacific at some point west of Princess St., $30,000; over the Red River, at some point north of the Louise bridge, $80,000; a bonus to St. Boniface on the completion of a bridge at the foot of Market St., $10,000.

OTTAWA, ONT.—Surveys are being made for the proposed interprovincial bridge between Hull and Nepean Point, for which this city has voted a bonus of $150,000.

WATER-WORKS.

WESTMINSTER, VT.—The Westminster Aqueduct Co. is investigating the question of an additional supply. Pres., R. D. Farr.

BROCKTON, MASS.—An additional water loan of $10,000 is desired.

CAMBRIDGE, MASS.—It is proposed to commence the construction of the high-service reservoir at Payson Park as soon as possible.

EVERETT, MASS.—The aldermen have voted in favor of issuing $70,000 of 4% 30-year bonds for extensions and to pay water debts coming due.

PITTSFIELD, MASS.—A. A. Fobes, Engr., writes us that the contemplated extension to Pontoosuc, noted last week, will require 7,198 ft. of 12-in., 3,350 ft. of 10-in. and 8,000 ft. of 8-in. pipe, and is estimated to cost $28,000, but that the work will be done by the city by day labor. The work will not be ordered until authority has been obtained to borrow money.

YALESVILLE, CONN.—It is reported that A. J. Brown, Jr., will erect a windmill and secure an independent supply.

FREEPORT, N. Y.—The citizens have voted, 168 to 45, in favor of works to cost about $40,000, including five miles of mains and 75 hydrants. An appropriation of $5,000 was also made for a fire engine and wells for the outlying districts.

JOHNSTOWN, N. Y.—J. J. Buchanan, Supt., informs us that the report for the new supply, noted Dec. 28, has not yet been completed.

NEWTOWN, N. Y.—The Citizens' Water Supply Co. will at once issue $25,000 of additional stock to make the extensions required by the contract noted last week. Secy., Augustus Rapelye.

NEW YORK, N. Y.—The department of public works will receive bids until Jan. 23 for a supply of cast iron pipe and special castings; also for furnishing and laying mains in Second Ave. between 48th and 42d Sts. and in 42d St. between 2d and 3d Aves.

NIAGARA FALLS, N. Y.—An election will be held Jan. 30 to vote on an issue of $50.000 of water-works bonds.

NORTH OLEAN, N. Y.—The North Olean Water Co. has been incorporated by W. S. Kent, D. W. Seeley, M. J. Houpie and others; capital stock, $3,000.

YONKERS, N. Y.—Jos. A. Lockwood, Supt., writes us that bids for about 460 tons of 24 to 4-in. pipe will be received until Feb. 1, and for laying some 3,000 ft. of 24-in. pipe about March 1. The city will lay three or four miles of pipe, mostly 8 to 6-in. during the coming season.

FREEHOLD, N. J.—A company has been organized, according to reports, to put in works at North Spring Lake.

GARFIELD, N. J.—The Hackensack Water Co. is reported to have offered to extend its mains to this place for $8,000.

JERSEY CITY, N. J.—The clerk has been directed to advertise for bids for furnishing and laying the 18,500 ft. of 12-in. pipe noted last week.

MAHONOY CITY, PA.—The city will probably contract soon for about 2½ miles of 10-in. and 3,000 ft. of 6-in. pipe, to be laid early in the spring.

RIDLEY PARK, PA.—Frank D. Kane, Clk., writes us that the works have passed into other hands and the service is not satisfactory, but that it will be some time before new works will be built.

TAMAQUA, PA.—Wise & Watson, Passaic, N. J., are reported to have recommended 14 and 16-in. mains laid with fewer angles and abrupt changes of grade than at present.

WAYNE, PA.—Drexel & Childs, owners of the works, are having surveys made for a reservoir near Valley Forge, according to reports, for a supply from the Perkiomen and Skippack creeks.

BENWOOD, W. VA.—A franchise has been granted to Col. Ben Wilson and associates for works. Surveys will be made at once and the construction of the plant probably commenced by April 1.

AIKEN, S. C.—Henry Busch, Chn. Com., writes us that Perry Andrews, Atlanta, Ga., has completed an artesian well for the city and that J. W. Baum, Atlanta, is preparing plans and specifications for works, to be completed shortly.

MACON, GA.—It is reported probable that an election will soon be held to vote on the purchase of the works at $550,000, the price agreed upon by arbitration.

QUINCH, GA.—Bids are asked until Feb. 6 for $20,000 of 5% water bonds, being the first bonds ever issued by the town for water or sewerage purposes. H. J. Davis, Tn. Clk.

ROME, GA.—The committee has been authorized to purchase pipe necessary to complete the works.

QUINCY, FLA.—A. L. Wilson writes us that bids are asked for $20,000 of 6% 30-year bonds and that the contract for works has not yet been awarded; supply to be from artesian well; population, 2,000.

ATHENS, O.—The trustees of the insane asylum have contracted with the Laidlaw-Dunn-Gordon Co. for two compound pumping engines of 3,000,000 gallons capacity.

BARBERTON, O.—It is reported that the contract for works has been awarded to a Toledo company.

GALLIPOLIS, O.—The city has issued $85,000 of 5% bonds for works to be built in the spring, according to reports.

ST. BERNARD, O.—Plans for works are being prepared and it is thought that an election will soon be held to vote on the construction.

TONTOGANY, O.—Works are being put in, according to reports.

BIG RAPIDS, MICH.—The effort to secure an additional daily supply of 1,000,000 gallons from wells has been officially declared a failure.

MARSHALL, MICH.—The estimate for works includes $27,000 for mains, $5,000 for a stand-pipe, $2,366 for 91 hydrants, $2,500 for two Buffalo pumps, $2,000 for a well; total, $50,000. An election was held this week to vote on the question of construction.

PANA, ILL.—The plans for works have been completed and accepted by the council, according to reports; estimated cost, $60,000.

WENONA, ILL.—An election will be held Feb. 6 to vote on an issue of bonds for works.

BOONE, IA.—The city clerk will receive bids until Feb. 7 for extensions, work to be completed by June 1.

FORT DODGE, IA.—The city has sold $16,000 of bonds and will put in new boilers and pumps, a second main and a stand-pipe, it is reported.

PARKERSBURG, IA.—M. F. Edwards, Tn. Recorder, writes us that the contract for works will be awarded Feb. 1, supply to be pumped from a well; population, 1,000.

WALKER, IA.—The citizens have voted to issue bonds for works.

WESLEY, IA.—It is reported that works will probably be put in this year.

MINNEAPOLIS, MINN.—F. W. Cappelen, Cy. Engr., has recommended a site for a proposed new reservoir, about half a mile north of the city limits.

RED WING, MINN.—It is proposed to extend the mains to Southside.

WASECA, MINN.—Bids are asked until Feb. 6 for $30,000 of 6% 20-year bonds for works. Thos. F. McLaughlin, Cy. Recorder.

POPLAR BLUFF, MO.—J. B. Reynolds, Cy. Clk., writes us that the council will soon employ an engineer to prepare plans for works, estimated to cost about $20,000; population, 3,600.

BAIRD, TEX.—Plans for works are being made by J. S. Thatcher, Dallas. It is reported that $10,000 of bonds will be issued.

BALLINGER, TEX.—Reports state that works will be put in.

DALLAS, TEX.—An appropriation of $35,000 has been made for increasing the supply, and Chester B. Davis, Chicago, has been engaged as consulting engineer.

AUBURN, NEB.—C. O. Snow, Cy. Clk., writes us that an election will be held Jan. 30 to vote on the question of works, the supply to be from wells; population, 1,500. Engr., A. A. Richardson, Lincoln.

BLOOMFIELD, NEB.—E. Lauver, Vil. Clk., informs us that a petition is being circulated asking for an election to vote on the question of works, but that no plans have yet been made.

CREIGHTON, NEB.—It is reported that the citizens have petitioned that an election be held to vote on an issue of bonds for $9,000 for works.

TRENTON, NEB.—R. H. Pember, Chn. Bd., writes us that the contract for works has been awarded to J. Churchill, at $7,000, the supply to be from wells. Engr., A. A. Richardson, Lincoln.

CANON CITY, COLO.—An election has been called to vote on an issue of bonds for extending and improving the works.

OAKLAND, CAL.—The Oakland Water Co., noted Dec. 28 as incorporated, has secured control of the artesian water belt at Alvarado and will award contracts at once for two large mains to that place, according to reports. It is intended to put several gangs of men at work as soon as possible and to have the mains completed in five or six months and this city piped within a year. Sites have been selected for distributing reservoirs in this city.

PROSPECT PARK, CAL.—The Cahuenga Valley Water Co. has been incorporated; capital stock, $30,000.

REDLANDS, CAL.—V. R. Barker, F. G. Ferland and John Carson are members of the company, noted last week, as incorporated.

KINGSTON, ONT.—The council has adopted a report recommending the purchase of a new engine and boiler.

KINGSVILLE, ONT.—Engineer Newman, Windsor, has been engaged to prepare plans; estimated cost, $20,000.

ARTESIAN WELLS.

OCEAN GROVE, N. J.—The water commissioners are reported as planning to put down an experimental artesian well to the depth of 1,400 ft.

QUINCY, MICH.—The council has decided to have a test well driven for fire purposes.

APPLETON, WIS.—The committee has decided upon an artesian well as a source of supply for the county buildings.

IRRIGATION.

LODGE POLE, NEB.—Efforts are being made to form a company to construct irrigation ditches from the valley to the hills on either side, according to reports.

CALDWELL, IDAHO.—Press reports state that a surveying party in charge of Engineer Hedden has left this city to make a survey of a canal on the north side of the Payette River, near Emmett. The project is in the hands of farmers and proposed settlers in that vicinity, and will cover probably upward of 20,000 acres of land. The water is to be taken from the river at a point some nine miles above Emmett, and the canal will have a capacity of about 20,000 ins., and be about 25 miles in length. It is expected to require two years to complete the work.

NEW COMPANIES.—Pennsylvania Canal Co., Phoenix, Ariz.; to construct a dam in Cave Creek several miles above the Phoenix mine to irrigate 30,000 acres of land in Paradise Valley; dam 125 ft. high, 75 ft. long at base and 614 ft. at crest; estimated cost, $250,000.——Antelope Valley Water Co., Los Angeles, Cal.; $3,000,000.——Chicago Ditch & Reservoir Co.; Trinidad, Colo.; $5,000.——San Gabriel Water Co., Chicago, Ill.; $4,000,000; S. D. Wilson, R. C. Fergus, E. B. Smith.

SEWERS.

FAIR HAVEN, MASS.—The committee on sewerage has recommended the adoption of a system, and Mr. Broughton of the Shone hydro-pneumatic system, has been invited to explain that system to the council. D. W. Deane, Secy. Com.

PAWTUCKET, R. I.—L. C. Heyward, C. E., writes us that plans are being made for sewers in the western district, and that it is the intention to build about 3,000 ft. of 36 to 48-in. brick storm sewers and about the same amount of 8 to 20-in. pipe sewers. The work will probably be commenced early in the spring.

HARTFORD, CONN.—L. W. Burt, Cy. Surv., informs us that the proposed intercepting sewer will probably be built in the spring. The work will include 6 miles of 56 and 30-in. brick sewers, average cut 15 ft., and 2,000 ft. of 18 to 10-in. pipe sewers, average cut 10 ft.; estimated cost, $375,000.

BUFFALO, N. Y.—Bids are asked until Jan. 23 for constructing 12 and 10-in. tile sewers, R. E. Ransom, Secy., Dept. Pub. Wks.

MOUNT VERNON, N. Y.—Bonds for $25,000 are to be sold for carrying on the sewer construction.

NORTH TARRYTOWN, N. Y.—We are informed that the board of sewer commissioners has contracted with J. Leland FitzGerald, Schenectady, for plans and specifications for a sewerage system for the village. It is intended to submit the question of construction to the people early in the spring.

TONAWANDA, N. Y.—Bids are asked until Jan. 25 for $65,000 of 5% sewer extension bonds. Andrew Ultsch, Secy. Com.

EAST ORANGE, N. J.—An ordinance has passed the township committee providing for an issue of $240,000 of 4% bonds for an outlet sewer from the disposal works to the Passaic River.

ENGLEWOOD, N. J.—It is reported that the sewer company has purchased land for sewage disposal works, chemical precipitation to be used.

NEWARK, N. J.—Ordinances have been passed for 15-in. pipe sewers in two streets.

BRADDOCK, PA.—The borough engineer of Rankin has prepared plans for a system; estimated cost, $50,000.

WILKES BARRE, PA.—Sewers are to be constructed in several streets.

ALEXANDRIA, VA.—The council has voted to petition for authority to issue $20,000 of 6% bonds to complete the system of sewerage.

PORTSMOUTH, VA.—A bill has been introduced in the legislature permitting the city to issue $165,000 of bonds for sewers.

COVINGTON, KY.—A bill has been introduced in the legislature authorizing this city to issue $150,000 of bonds for a system.

ASHTABULA, O.—Sewers are proposed for several streets.

CINCINNATI, O.—Bids are asked until Feb. 1, by the board of administration for sewers in two streets.

HARBOR, O.—Plans for a system are nearly completed, according to reports.

WARREN, O.—It is proposed to issue bonds for $20,000 for the proposed Red Run sewer.

WEST CLEVELAND, O.—One of the conditions proposed for annexation to Cleveland is that the city construct a system of sewers in this village, according to the plans of Mr. Kraus, Vil. Engr.

EVANSVILLE, IND.—Sewers are to be constructed in four streets.

HUNTINGTON, IND.—H. H. Wagoner, Cy. Engr., writes us that work will probably be commenced in the spring on about 5,000 ft. of 4 or 5-ft. sewers, average cost 10 ft., and on 2,000 ft. of pipe sewers, average cut 5 ft.

MASON CITY, IA.—Plans are proposed for a system for Willow Creek.

TEXARKANA, ARK.—This city and Texarkana, Tex., have awarded a 25-year franchise to W. H. Ward and associates, Little Rock, and it is stated that the construction of a system will be commenced within 20 days.

DALLAS, TEX.—An appropriation of $11,000 has been made for sewers in East Dallas.

STREETS.

CENTRAL FALLS, R. I.—We are informed that bids are being received for 500.00 stone paving blocks, 8 to 14 x 3½ to 4½ x 7 to 8 ins., and for 3,000 ft. of curbing, to be used in Broad St.

NEW CASTLE, PA.—It is proposed to pave several streets with asphalt or brick.

YORK, PA.—The council is considering a large loan for paving.

SMITHSBURG, MD.—An election is about to be held, according to reports, to vote on the question of bonds for public improvements.

MACON, GA.—The chairman of public works will receive bids until Feb. 3 for all necessary curbing, flagging and Belgian blocks for 1894.

JACKSONVILLE, FLA.—Bids are asked until Jan. 26 for 69,055 sq. yds. of paving with Belgian blocks, vitrified brick, or sapless cypress blocks. A. F. Harley, Cy. Engr.

CINCINNATI, O.—Bids are asked until Feb. 5 for paving Jackson St. with brick.——The board of administration has decided to pave Spring Grove Ave. with brick, at a cost of about $200,000.

MOUNT VERNON, O.—The city council will proceed with the paving of North Main St., at a cost of about $13,000. This work was stopped last summer by an injunction.

PLEASANT RIDGE, O.—Bids are asked until Feb. 5 for macadamizing Auten Ave. Engr., J. M. Harper, Cincinnati.

EVANSVILLE, IND.—The board of public works has voted to pave six streets with brick.

HUNTINGTON, IND.—Bids will probably be asked in March for paving 40,000 sq. yds. with brick or blocks. H. H. Wagoner, Cy. Engr.

MONROE, MICH.—Bids are asked until Jan. 29 for paving Monroe St. with vitrified brick. Jno. Steiner, Cy. Clk.

ST. LOUIS, MO.—The harbor commissioners are reported as about to do granite paving to cost $30,000.

HOUSTON, TEX.—Bids are asked until Jan. 29 for sidewalks in about 50 streets. John T. Browne, Mayor.

TEXARKANA, TEX.—The council has voted to issue $30,000 of bonds, including $6,000 for paving Broad St.

DENVER, COLO.—The board of public works will advertise for bids for $400,000 of 4% improvement bonds.

ELECTRIC LIGHT AND POWER.

POULTNEY, VT.—The residents of this village have voted in favor of electric lights. The plant will be located at Carvers Falls.

WARREN, MASS.—The Palmer & Monson Electric Co. has organized the Central Massachusetts Electric Co. to furnish this place, West Warren and West Brimfield at once, and other towns later, with electricity for lighting and power purposes. The capital stock will be $150,000; Pres., A. M. Young, Waterbury, Conn.; Treas., C. B. Fiske, Palmer.

EAST ORANGE, N. J.—The clerk has been directed to advertise for bids for 100 to 200 arc lights for 10 years. The town is now using gas lights.

READING, PA.—The committee on police has been authorized to advertise for bids for lighting the streets and city hall.

LYNCHBURG, VA.—The committee will receive bids for a site for a proposed electric light plant.

CHARLESTON, W. VA.—It is proposed to issue $20,000 of bonds for a municipal plant.

CLEVELAND, O.—Bids are asked until Jan. 26 for one 115-volt compound-wound dynamo, having a capacity of 300 16-c. p. 60-watt, 110-volt incandescent lamps; also for one single cylinder, non-condensing, horizontal, automatic cut-off engine, which shall develop 50-brake horse power. J. H. Farley, Dir. Pub. Wks.

PORTLAND, IND.—The council has awarded the contract for street lighting to Fred Birnell, at $84 per year for each 2,000-c. p. arc light.

MANCELONA, MICH.—A company is being organized to put in an electric light plant, according to reports.

MILWAUKEE, WIS.—Capt. Pabst has been granted a franchise to furnish electric light and power in wards 3, 7, 4 and 2.

WINONA, MINN.—Bids are asked until Feb. 11 for lighting the streets for 3, 5, 7 or 10 years, with arc or incandescent lights or with gas; also for furnishing a plant for municipal lighting. O. H. Clark, Cy. Recorder.

FAIR HAVEN, WASH.—The company offers to furnish 34 intersection arc lights of 2,000 c. p., at $11.50 each per month, 40 at $11.25, 50 at $10, 75 at $9.50, or 100 at $9. The contract which expired Jan. 1 was for 52 at $10 each per month.

NEW COMPANIES.—Healdsburg Electric Light & Power Co., San Francisco, Cal.; $25,000; A. H. and Geo. R. Babcock, D. H., J. T. and A. T. Ward.——Harbor Power & Light Co., San Francisco, Cal.; $100,000; A. Devoto, W. H. Broadwell, H. J. Kuhlmeyer.——Suburban Electric Light & Power Co., Chicago, Ill.; $15,000; A. F. Dexter, W. Phillipson, M. C. Carr.——A. C. Wolfram Electric Co., of St. Louis, Mo.; $20,000; A. C. Wolfram, T. J. Wolfram, Wm. Bulcker.

CONTRACT PRICES.

SEWER FLUSHERS.—Denver, Colo.—The board of public works has contracted with Andrew Rosewater, Omaha, Neb., for 100 flushing siphons for the new sewers, at $14.50 each, according to reports.

STEEL RAILS.—Press reports state that of the 43,000 tons of new steel rails ordered by the Pennsylvania Co. for this year's work, 36,000 tons were bought at Eastern mills, at $24 a ton, and 7,000 at Western mills, at $25 a ton. Most of the orders were for 85-lb. rails. No more 100-lb. rails were ordered.

PIPE.—Brockton, Mass.—The water commissioners have awarded the contract for 1,800 tons of 30, 24, 12 and 6-in. cast iron pipe and 45 tons of special castings to R. D. Wood & Co., Philadelphia, at $22.89 per gross ton for the pipe and $51.50 for special castings, delivered f. o. b. cars in this city. The other bids were: Warren Foundry & Machine Co., Phillipsburg, N. J., $23.30 to $24.30, and $46; Howard-Harrison Iron Co., Bessemer, Ala., $23.49, and $49.94; McNeal Pipe & Foundry Co., Burlington, N. J., $24.07, and $53.20 and $90; Anniston Pipe & Foundry Co., Anniston, Ala., $24.42, and $50.49; Reading Foundry Co., Reading, Pa., $25.31 to $26.21, and $56.

SEWERS.—Milwaukee, Wis.—The contract for 500 lin. ft. of 10-ft. brick tunnel sewer in the town of Wauwatosa has been awarded to Wm. Forrestal at $18.75 per lin. ft. for the tunnel sewer and $1 per lin. ft. for 700 lin. ft. of ditch. This sewer will be 2½ miles in length when completed and will probably be two years building. The contract for this first section was awarded at $15.65 per ft. for the tunnel sewer and $1 for the ditch, and the bids published in our issue of Nov. 30, but the successful bid was afterward declared a mistake and the work readvertised. G. H. Bengenberg, Cy. Engr., informs us that the other bids received last week for the tunnel sewer were as follows:

W. Goff & W. Turner	$22.75	K. Bowler	$20.80
Nic. Forrestal	21.00	Jas. Copes & Sons	21.50
David Turner	23.00	N. F. Reichert	22.00
Geo. J. Markey	20.00	Jno. J. Crilley	21.90
R. J. Wilson	22.00	Frank B. Burness	27.75
A. Keilun	25.50	H. A. Schmitz	21.00

WATER-WORKS.—Spokane, Wash.—The lowest bids received Dec. 27 for the new works were published Jan. 11. Press reports state that the contracts for the four sections have been awarded to R. A. Jones, at $197,900, $37,120, $30,800 and $74,000, respectively. The contracts for these sections were awarded, as stated in our issue of Dec. 14, at $229,450, $18,900, $77,928 and $29,000, respectively, but injunction proceedings, owing to the award of the first section, caused all the work to be readvertised. The lowest bid for the first section at that time was that of L. J. Martin, at $129,781. The prices of R. A. Jones' bid Dec. 29 were as follows: Section A, timber dam, complete, $31,281; range ashlar, at $16; range rubble, at $11; common rubble, at $5.50; 1, 2 and 3 concrete, at $10; 1, 3 and 5 concrete, at $6; 1, 3 and 8 concrete, at $4.50; coping, at $1 per sq. ft.; gravel excavation, 23 cts. per cu. yd.; fill under water, 25 cts.; sheet piling, at $5 per lin. ft.; two head gates, $900; power station, $4,500. Sec. B, American turbine wheels, $18,000; 12 ft. 4-in. flume, $4,620; flume gates, $12,500. Sec. C, four Holly pumps, $30,800. Sec. D, 24-in. conduit, at 5½ cts. per lb.; four water valves, at $320; one air valve, $250; five blow-offs, at $30; five crosses, at $60; two T's, at $50; one T, at $55; one reducer, $25; three bends, at $20; all necessary deflection joints, $400.

GARBAGE DISPOSAL.—Syracuse, N. Y.—The following bids were received Jan. 4 for the disposal of garbage: New England Construction Co., proposal No. 1, erect plant of 30 to 60 tons capacity on land provided by city for $28,000; reduce garbage delivered at plant for 15 years; pay city $1,680 per year; at end of 15 years plant becomes property of city. No. 2, reported same as preceding except a $2,800 annual rental fee. No. 3, 30 to 50 tons or more daily to be reduced for 15 years at 10 cts. per ton, garbage to be house offal and delivered at works free of charge. No. 4, to be erected on land provided by ourselves, at 20 cts. per ton.

Onondaga Fertilizer Co., to treat garbage for 20 years on these conditions: to construct plant within city limits without expense to city; city to deliver 40 tons of green garbage per day, except Sundays; 33 tons at 20 cts., 30 tons at 25 cts., 25 tons at 30 cts., less amount at 50 cts.; garbage to be free from ashes, wood and shavings.

Engle Sanitary & Cremation Co., New York, 50-ton plant on land furnished by city; garbage not over 20% coal ashes; maximum cost 60 cts. per ton, and expenses and repairs for five years, $1,500; 90 days required to construct plant; city to own plant upon paying $14,500, coal used as fuel, or $15,500 for plant to use petroleum oil as fuel; 30-ton plant at $10,000 or $10,500 respectively.

S. C. Smith, of the Vivarttas system, plant on ground furnished by city, corrugated iron building, to incinerate within 10 consecutive hours 30 tons of garbage, including nightsoil, for $12,499, 45 tons for $17,499, 60 tons for $22,499.

American Garbage Cremator Co., Boston, 30 to 50-ton, Brown pattern, $14,000; guaranteed capacity six tons per hour; cost not to exceed 40 cts. per ton; repairs for five years not to exceed $200; will operate plant for two or four weeks at 45 cts. per ton.

Dixon Sanitary Cremation Co., Findlay, O., plant on land furnished by city; 30 to 50 tons of nightsoil and garbage without stench, for $9,665, or $8,415 for crematory alone, city to construct building; cost of cremation of garbage delivered at plant not to exceed 20 to 30 cts. per ton, according to price of fuel.

MISCELLANEOUS CONTRACTS AND SUPPLIES.

JAIL.—Milton, Fla.—Bids are asked until Feb. 6 for the erection of a county jail. J. E. Creary, Chn. Co. Comrs.

CEMENT.—New York, N. Y.—The department of docks will receive bids until Jan. 25 for 8,000 bbls. of Portland cement.

CHEMICAL ENGINE.—Brooklyn, N. Y.—Bids are asked until Jan. 22 for a chemical fire engine. John Ennis, Comr. Fire Dept.

PARK BONDS.—Cleveland, O.—The city has sold $300,600 of park bonds for $311,700 and bids will soon be received for an additional $200,000.

ARCHITECTURAL COMPETITION.—New York, N. Y.—Plans are wanted until Feb. 15 for an armory building. Brig.-Gen. Louis Fitzgerald, Armory Bd. Comr.

DRAINAGE.—Macon, Ga.—The county commissioners and city officials are considering plans for draining the swamp below this city, at an estimated cost of $10,500.

COURT HOUSE.—Rochester, N. Y.—Bids are asked until Feb. 12 for constructing a fireproof court house. J. Foster Warner, architect; Lyman M. Otis, Chn. Bldg. Com.

CAPITOL IMPROVEMENTS.—Columbus, O.—The special commission has recommended the erection of a wing on the south side of the capitol at an estimated cost of $250,000.

PUBLIC BUILDING BONDS.—Texarkana, Tex.—The council has authorized an issue of $30,000 of 4% bonds, including $10,000 for a city hall and jail and $14,000 for a brick schoolhouse.

DRAINAGE DITCH.—Wapakoneta, O.—Bids are asked until Jan. 25 for constructing the West Prairie joint ditch as located in Wayne, Goshen and Stokes townships. The work is in 71 sections. Samuel Craig, Engr.

CANAL IMPROVEMENTS.—Albany, N. Y.—Edward Hannan, Supt. Pub. Wks., has awarded the contract for removing obstruction from prism of the Erie Canal in city of Buffalo to Hingston & Woods, Buffalo, at $7,872.

DREDGING.—Buffalo, N. Y.—The contract for dredging the Buffalo River to a depth of 19 ft. between Hamburg and Ohio Sts. has been awarded to Bapst & McNaughton, according to reports, at about $186,000, the work to be completed by May 1, 1895.

MASONRY AND IRON WORK.—Providence, R. I.—The local engineers of the New York, New Haven & Hartford R. R. Co. have been instructed to prepare specifications for receiving bids for the masonry and ironwork for the new passenger station. About 8,000 cu. yds. of masonry will be required for the abutments along Francis St., according to reports, and the masonry alone is expected to cost $60,000.

INDUSTRIAL NOTES.

W. K. CLYMES, of Jersey City, N. J., has completed the moving of brick buildings along the Pennsylvania R. R. at Elizabeth, N. J.

THE INGERSOLL-SERGEANT DRILL CO., of New York, states that it now has 20 channelers at work on the Chicago drainage canal, instead of 16, as stated last week.

THE LAIDLAW-DUNN-GORDON CO., of Cincinnati, O., has a contract from the trustees of the insane asylum at Athens, O., for two compound pumping engines of 3,000 gallons capacity.

THE C. A. C. TIE PLATE CO., of New York, N. Y., reports orders for 501,000 tieplates for the Boston & Albany R. R., to be used on chestnut ties under 95-lb. rails. The plates are 9 × 6 ins. and weigh about 4 lbs. each.

ARTESIAN WELL MACHINERY.—Mr. C. Ernest Mayes, artesian well contractor, 41 St. Mary St., Camperdown, Sydney, New South Wales, will be obliged for catalogues of artesian well machinery and list of published articles in book or other form of American authorship. Address him direct.

THE AMERICAN HOIST & DERRICK CO., with headquarters at St. Paul, Minn., and having branches at Chicago and Cincinnati, announces the removal of its Chicago branch from 48 South Canal St. to 54 to 60 South Canal St., where it has enlarged facilities and accommodations. The company reports that the prospects for spring business are good, and that indications are that the period of depression is practically over.

THE SOUTHWESTERN BRIDGE & IRON CO., of Fort Worth, Tex., was organized in June, 1893, with an authorized capital of $100,000, but owing to the general business depression, active operations were deferred until the present. At the stockholders' annual meeting on Jan. 9 resolutions were passed authorizing the managment to put the plant in readiness for operation at once. Gen. Man., Geo. H. Hutchinson.

THE J. W. FOWLER CAR CO. announces that its new works in Elizabethport, N. J., are now completed, and that it is ready to build and ship promptly all types of street railway cars and snow plows for electric, cable or horse service. The works are especially designed for quick delivery orders. The company is also prepared to supply at short notice car registers, stoves, sandboxes, car trimmings and other car equipment. Pres., J. W. Fowler (formerly president of the Lewis & Fowler Mfg. Co.); Secy., R. C. Swan. The New York offices are in the Havemeyer Building, corner of Cortlandt and Church Sts.

NEW COMPANIES.—Wheeler Rail Joint Co., New York, N. Y.; $50,000; H. L. Terrell and S. F. Sullivan, of New York, and S. Wheeler, of Westport, Conn.——United States Headlight Co., Albany, N. Y.; $1,500,000; electric and other headlights; I. A. Williams, Utica, N. Y.; John Kirby, Dayton, O., and W. W. Willits, Chicago, Ill.——Brown Automatic Car Coupler Co., Alexandria, Va.; $100,000; Pres., A. H. Semmes; Secy., T. W. Bedford.——Georgia Cement Co., Fort Valley, Ga.; Pres., A. S. Giles; Secy., W. E. Matthews.——Worthington Car Coupler Co., Chicago, Ill.; $100,000; A. J. Worthington, L. W. Dickerson and A. H. Simmes.——Crane & Jack Co., Chicago, Ill.; $100,000; A. M. Gilbert, A. D. Macgill and R. L. Latham.——Western Paving & Supply Co., Milwaukee, Wis.; $60,000; F. Kraus, H. Weber and J. T. Bannen.——R. D. Wheaton Bridge Co., Chicago, Ill.; $50,000; R. D. Wheaton and G. F. Hong.——Galveston Cement Pipe Works, Galveston, Tex.; $20,000; Isaac Heffron, G. H. Henderson and M. F. Sherwood.——Fidelity Construction Co., Chicago, Ill.; $250,000; J. L. Perkins, Rufus Thompson and John B. Stanmour.——Sewall Harbor & Channel Improvement Co., New Orleans, La.; $100,000; Pres., H. F. Sewall; Vice-Pres., L. M. Soniat; Secy., A. F. Wrotnowski.

METAL MARKET PRICES.

RAILS.—New York: $26 to $25 at eastern mills and at tidewater; old rails, $12 to $13 for iron and $10 to $10.50 for steel. Pittsburg: $24 for standard sections. Chicago: $25 to $27; old rails, $13 for iron and $7.50 to $10 for steel.

TRACK MATERIAL.—New York: angle bars, 1.3 to 1.4 cts.; spikes, 1.7 to 1.9 cts.; track bolts, 2.2 to 2.4 cts. with square and 2.3 to 2.5 cts. with hexagon nuts. Chicago: angle bars, 1.55 to 1.6 cts.; spikes, 1.9 to 1.95 cts.; track bolts, 2.55 to 2.6 cts. with hexagon nuts.

FOUNDRY PIG IRON.—New York: $12.50 to $14. Pittsburg: $11.25 to $12. Chicago: $12 to $13.50.

LEAD.—New York: 3.2 cts. Chicago: 3.05 cts.

NAILS.—Pittsburg: $1.10 to $1.30 for wire, 95 cts. at mill for cut.

STRUCTURAL MATERIAL.—New York: beams, 1.6 to 2.25 cts.; channels, 1.6 to 2 cts.; angles, 1.55 to 1.7 cts.; tees, 1.75 to 2 cts.; universal mill plates, 1.5 to 1.65 cts.; steel plates, 1.45 to 1.55 cts. for tank, 1.6 to 1.7 cts. for shell, 1.9 to 2 cts. for flange, 2.25 to 2.5 cts. for firebox. Pittsburg: beams, 1.45 to 1.6 cts.; channels, 1.45 to 1.6 cts.; angles, 1.45 to 1.5 cts.; tees, 1.7 to 1.75 cts.; universal mill plates, 1.45 to 1.5 cts.; steel plates, 1.35 to 1.37 cts. for tank, 1.55 to 1.6 cts. for shell, 1.65 to 1.75 cts. for flange, 1.85 to 1.95 cts. for ordinary firebox and 2 to 2.15 cts. for railway firebox. Chicago: beams, 1.65 to 1.75 cts.; channels, 1.65 to 1.75 cts.; angles, 1.6 to 1.65 cts.; tees, 1.9 to 2 cts.; universal plates, 1.6 to 1.65 cts.; steel plates, 1.55 to 1.65 cts. for tank, 1.75 to 1.85 cts. for shell, 1.85 to 2.05 cts for flange, 2.75 to 3 cts. for firebox.